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COLLISION AVOIDANCE RADAR BRAKING SYSTEMS INVESTIGATION. PHASE II STUDY. VOLUME 1. SUMMARY REPORT

by

R. E. Wong, W. R. Faris, W. O. Grierson, W. C. Troll, Y. M. Powell, and D. V. Payne

Abstract

An instrumented test automobile equipped with an automatic noncooperative radar brake system was used to gather and classify experimental data on radar false alarms as a function of various radar system parameters such as detection range cutoff (RCO), antenna beamwidth, range delay, and vehicle velocity. The test vehicle was driven over three roadways in Detroit, Michigan, under actual traffic conditions typical of much of the high density, high speed, urban and suburban driving in the U.S. Results showed that both the detection range cutoff and antenna beamwidth have a pronounced effect upon the false alarm problem; the range delay and vehicle velocity are of secondary importance. Analyses were also performed to determine the effects of radar design parameters such as beamwidth and frequency on rain clutter and radar detection probability for three target classifications ranging from pedestrians to full-size passenger cars.

Computer simulation was employed to evaluate the cost effectiveness of 36 system configurations. Effects of changing system design parameters and operational differences within each system were also examined. The 1973 traffic accident data sources representing six states and six counties were selected to provide the largest practical data base and to reduce biases due to geographic, economic, and reporting agency influences. System evaluation was made in a comparative form to show estimated values to society over the lifetime of the vehicle, and benefits were estimated in reduction of fatalities, injuries, and property damage. It was estimated that an automatic noncooperative radar brake system satisfying the preliminary system performance specifications in this report could prevent approximately 18% of all traffic accidents nationwide, thus saving 15% of lives involved in fatal accidents annually. It appears that false alarms due to non-hazardous targets could be suppressed and the system still be cost effective in accident reduction. The primary remaining problems are to demonstrate the installation feasibility of such an anticipatory braking system in vehicles ranging from subcompact to full-size cars and to resolve the need for a four-wheel anti-lock system as a requirement in conjunction with the automatic radar braking system.

SECTION 1. INTRODUCTION

Recognizing the potential application of radar braking system as an anticipatory braking system in reducing motor vehicle traffic accidents, the National Highway Traffic Safety Administration (NHTSA) initiated a two-phase study program to conduct a systematic investigation into the areas of system requirements, operational mode, technological constraints and operational implementation. A three-month Phase I Study was initiated in June 1974 and completed in September 1974. The objectives of the Phase I Study were:

- Conduct a state of the art investigation of radar braking systems, existing designs, system performance and limitations.
- Determine cost-effectiveness in terms of preventable accidents if all automobiles were equipped with radar braking systems.
- Identify and prioritize system problem areas by comparing system requirements against system performance capabilities for further study in Phase II.

Results of the Phase I Study indicated that an automatic noncooperative radar brake system may

provide a significant benefit in preventing accidents otherwise caused by inattentive or tardy driver response. It further indicated that the radar augmented braking system is technically feasible for installation in passenger automobiles. However, the Phase I Study also identified some technological problems associated with the automatic noncooperative radar brake system. One of the major problem areas is in achieving sufficient target discrimination to allow rejection of non-hazardous objects and to maintain a sufficient low false alarm rate while retaining recognition capability on all potential hazards.

In May 1975 NHTSA initiated a nine-month Phase II Study with the following objectives:

- Conduct experimental investigation and analysis to resolve the target discrimination problem.
- Perform sensitivity analysis by means of computer simulations to determine system performance trade-offs and related cost/benefits, and
- generate a preliminary systems performance specification of the recommended system(s).

This report presents a summary of the results accomplished during a nine-month Phase II Study. The target discrimination experimental study was conducted using an instrumented test vehicle equipped with an automatic noncooperative radar braking system to gather parametric data under typical traffic conditions. The test vehicle was driven over three selected types of roadway within the metropolitan area of Detroit, Michigan, which typify much of the high density, high speed, urban and suburban driving in the United States. These included an urban expressway, a divided main artery, and a two-way main artery.

As an adjunct to the experimental study, analytical analyses were also performed to determine the effects of radar design parameters (beamwidth and frequency) on rain clutter and to determine radar detection probability for three target classifications ranging from pedestrians and bicyclists to full-size passenger cars.

A sensitivity analysis was conducted to evaluate the system cost-effectiveness of the 36 system configurations considered in the study. The effects of changing system design parameters and the operational differences within each system were also examined. The traffic accident data sources representing six states and six counties were selected throughout the United States to provide as large a data base as practical in the sensitivity analysis. The use of these accident data sources will reduce the majority of the biases due to geographic, economic, and reporting agency influences. The methodology chosen for the analysis was a computer simulation program. The evaluation of these systems was in a comparative form to show the estimated values to society over the useful lifetime of the vehicle. The benefits were derived from the estimated saving or reduction in fatality, injury, and property damage from the 1973 accident level.

Based upon the results of both experimental study and sensitivity analysis, a preliminary system performance specification is defined for an automatic noncooperative radar system which is believed to be achievable in early 1980.

SECTION 2. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

A cost-effective automotive radar braking system is within the reach of present day technology. This has been established through statistical evaluation of the accident population and assessment of accepted societal costs associated with human fatalities, injuries, and property damage.

The system mode of operation must be automatic/noncooperative in order to provide quick consistent response to the variety of obstacles presented in all aspect angles, which is necessary to accrue sufficient benefit.

Vehicle stability during braking must be preserved to the degree required for avoiding another accident. Stability factor quantization was beyond the capability of the analysis conducted in this study. Consequently, a resident anti-lock system remains a desirable but as yet unsubstantiated argumentation. Resolution of this question could best be reached through actual experimental tests of radar-brake-equipped vehicles.

Discrimination against false targets (approaching a zero-alarm rate) is achievable primarily through restricting the maximum allowable radar detection range and employing a highly directive, low side lobe radar antenna. Values of 150 feet and 2.5-degree beamwidth are acceptable in this respect. Although somewhat wider beamwidth might be tolerated, the cut-off range of 150 feet is a realistic maximum which must be implemented in an absolute sense, as opposed to a result of signal processing logic operations.

The above stated requirement for a narrow beam antenna in conjunction with the necessity of physical dimensions compatible for vehicle installation place the radar operating frequency above 24 GHz. At this frequency and above, backscatter energy from heavy rain constitutes a potential false target, and special design measures must be taken to desensitize the system to this phenomenon.

Benefits accruable to system operation in rain are small enough to consider the viability of an operating system which offers degraded or self-inhibiting performance in the presence of rain. Any of the three common *rf* modulation formats—pulse, *FM/CW*, diplex *CW*—can provide this desensitization feature. Although a short pulse radar is most conveniently implemented in this respect, the concomitant low *rf* duty factor places high peak power requirements on the transmitter diode which represents a technological risk. The diplex, interrupted *CW* radar is considered to be a lower risk and less complex approach.

System performance in curves also returned only minor incremental benefit, which could be discounted if an inhibit function activated under these conditions could provide needed increased security against false alarming on roadside peripheral objects. A lateral-g threshold sensor is one potential implementation approach.

Some delay between target detection and brake actuation should be built into the system to avoid overreacting against transient targets. This time delay should be inversely related to closing velocity so that reaction time is shorter at higher speeds where more prompt activation is called for. A Doppler cycle counter automatically provides this characteristic by generating an effective range delay, independent of closing velocity.

The statistical traffic accident library and radar brake model generated and exercised in the computer simulation are useful tools which can be base-line applied to expanded comparative analysis of braking systems with characteristics other than those defined by the 36 types included in this study.

Recommendations

Based on the conclusions discussed above, the following areas of further study are recommended:

- A comprehensive experimental program should be undertaken to:
  (1) Demonstrate the design and fabrication feasibility of an automatic noncooperative radar brake system capable of meeting the preliminary performance specification set forth in this study. The system component hardware should reflect closely projected technology in mid-1980.
  (2) Demonstrate the system integration feasibility and installation compatibility of the radar brake system in test vehicles ranging from subcompact to intermediate size passenger cars equipped with various types of brake actuation.
  (3) Conduct experimental testing of the radar brake test vehicles in a controlled test course with the objectives of determining the system effectiveness in simulated collision avoidance environment.
- Since one of the basic assumptions made in the study is that the vehicle stability is always maintained during braking so that no causation of another accident is attributable to the radar brake system, an experimental test program should be conducted with the radar brake vehicles equipped with four-wheel anti-lock systems to determine the validity of the assumption.
- The possible effects of electromagnetic interference of the radar brake system were not examined in the study. It is recommended that an analytical and experimental study be made to determine the EMI (electromagnetic interference) effects from sources such as: commercial high power lines, radio and TV stations, high power radar installations (i.e., airports, military installations, etc.), on-board ignition, radio telephone, citizens band radio, etc.
- Various types of radar systems are susceptible to backscatter energy from heavy rain which could constitute a potential false target. A study should be made of techniques for detecting the presence of heavy rain reflections and to investigate system design implementation for self-inhibiting performance in the presence of heavy rain.
- Additional system cost-benefit analysis should be performed for the recommended system using the computer program developed with a more exact vehicle control law instead of the linear control law used in the study and using the latest traffic accident data (preferably 1975 data).

SECTION 3. TARGET DISCRIMINATION STUDY

The objective of the experimental target discrimination study is to gather and classify experimental data on radar false alarms as a function of various radar system parameters. The data are to be used in an analytical study to assess the impact of false alarms on the cost effectiveness of the radar brake.

False alarm rates were gathered with a test vehicle driven over selected routes under typical driving conditions. Several radar design parameters were varied during the study. These parameters included the radar antenna beamwidth, maximum detection range, and Doppler delay threshold. An attempt was also made to study the effect of vehicle velocity on radar false alarms.

Test Vehicle Description and Instrumentation

The test vehicle used in the experimental study was a 1973 Lincoln Continental equipped with an automatic radar braking system of the noncooperative type. It also was equipped with a four-wheel anti-lock system which interfaces with the radar brake command and control functions.

The use of an existing test vehicle does not in any way constrain the validity of the experimental data for objective evaluation of various radar brake systems.

A block diagram of the general automotive radar brake system as well as the particular implementation used in the study is shown in Figure 1. The radar sensor emits energy at a microwave frequency and detects reflections from a target vehicle or obstacle. In the configuration used in the study, range and range rate are computed by the radar; however, some experimental radar braking systems have been known to compute range rate only.

The signal processor accepts the radar data and inputs from the vehicle, such as speed and steering angle, for computation of the brake control signal. The brakes are actuated either electromechanically in the automatic mode or by the driver in the semiautomatic mode. The driver exercises control over the radar brake system through a display and control interface.

Radar outputs and false alarm data were recorded on a Consolidated Electrodynamics 9-channel oscillograph recorder powered by a separate battery-inverte power supply in the trunk of the vehicle. Radar an braking functions which were recorded are as follows

Signal Presence
Warning Signal
Brake Control Signal—N= 512
Brake Control Signal—N=1024
Vehicle Velocity
Signal Strength
Range
Range Rate
Event (coded for false alarm identification)

The recorder bandwidth is a function of the galvanometer used in each channel. For radar functions such as range, range rate, vehicle velocity, and event channel, the galvanometer bandwidth is 11 Hz. For the fast rise, sometimes relatively short digital functions such as signal presence, warning and brake control signals, low sensitivity 180 Hz galvanometers were used. For signal strength, a high sensitivity, 135 Hz galvanometer was used. Although the recorder has a chart drive capable of 4 inches per second, data runs were recorded at 0.25 inch per second which permitted up to 80 minutes of continuous recording on a 100-foot roll of paper.

Test Conditions

The test conditions are represented by a matrix shown in Figure 2, which represents all of the test conditions which were investigated. All possible combinations of the four parameters (antenna beamwidth, test course, maximum detection range, and vehicle velocity) result in a set of 81 test conditions. Each test was to be repeated once, possibly twice, resulting in a minimum of 162 separate data runs.

During actual testing, some deviations from the test plan were made by adding a maximum detection range of 150 feet and omitting a few runs for the 10-degree antenna system and for some of those involving a target vehicle. The omitted runs were selected as those which were of lesser significance to the study. Also, because of the results obtained with the 4.5-degree antenna, no data were taken with the 2.5-degree antenna for the detection range cutoff of 100 feet. At this range, the 4.5-degree antenna was sufficient to eliminate virtually all false alarms.

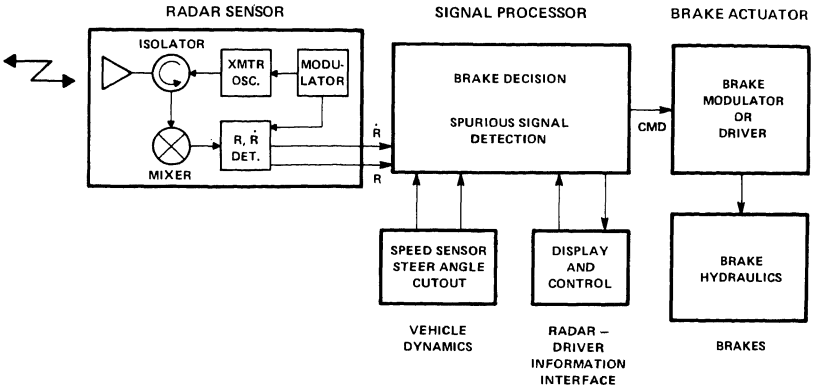

Figure 1. Radar Brake System Block Diagram

The test plan also provided for the investigation of two different vehicle velocities (V_{max} and V_{min}) with additional tests to be performed following a target vehicle at V_{max}. When traffic is present, as was almost always the case, the vehicle velocity could not be maintained constant, and little difference existed between V_{max} and V_{min}.

2.5° Beam	Test Course (1) John Lodge	RCO = 300′	V_{MAX}
4.5° Beam	Test Course (2) Telegraph	RCO = 200′	V_{MIN}
10° Beam	Test Course (3) Southfield-10 Mile	RCO = 100′	V_{MAX} (target vehicle)

Figure 2. Test Matrix—Target Discrimination Study

Test Course Selection and Description

Three test courses within the metropolitan area of Detroit were selected for the road test experiment. These test courses typify much of the high density, high speed, urban and suburban driving in the United States. These included an urban expressway, a divided main artery, and a two-way main artery. Some of the test course characteristics are:

(1) Urban expressway (John Lodge—20 miles) characterized by medium speed (45 to 55 mph), high traffic density, and many potential false alarms.

(2) Divided main artery (Telegraph Road—20 miles) characterized by medium speed (40 to 50 mph), medium traffic density, intersections, and merging traffic.

(3) Two-way main artery (Ten Mile Road—15 miles) characterized by low speed (30 to 40 mph), high traffic density, and adjacent lane traffic.

Test Results and Discussion

Immediately following the completion of a test run, the recorded data were examined as they developed under ultraviolet light and annotated for later further reduction. Event marks on the record were compared with visual observations, and identification of specific false alarms was made where possible. In the case of overpasses, guardrails, and parked and adjacent lane traffic, this was relatively easy. In the case of the numerous signs encountered, it was not always possible to identify each sign; therefore, signs are not identified specifically. In a few cases, visual observations did not provide a clue as to the source of the

false alarm; however, it was often possible to make an identification by examining the record.

In all, there were 184 test runs made. In addition, there were a total of 23 preliminary test runs made to check out the various instrumentation.

It became apparent early in the road test program that some test parameters had more effect on false alarms than others. Some difficulties were encountered in evaluating the effect of vehicle velocity on false alarm rate due to the achievable range of velocities, which was inconsistent and traffic dependent. Vehicle velocity was a strong function of traffic volume, and in general low speed runs were performed in the right (slow) lane and high-speed runs were made in the left or center (fast) lanes. In any case, vehicle velocity does not appear to have a great effect on false alarms.

Test results revealed that, in the case of the 4.5-degree antenna, and especially in the case of the 10-degree antenna, the presence of a target vehicle spaced 100 feet ahead of the radar vehicle had little effect on false alarms. It had been anticipated that possibly fewer false alarms would be encountered because of the target vehicle blocking the radar propagation paths and because of strong signal capture by the energy return from the lead vehicle. However, in maintaining a separation of 100 feet, it was necessary in practice to match speeds; this results in zero or very low Doppler frequency. Low frequency signals are attenuated with respect to high frequencies; thus, the circuitry responds readily to the higher frequency false alarm signals if present. For the wider-beam antennas, a vehicle at 100 feet does not substantially block the propagation path. In the case of the 2.5-degree antenna there were indeed fewer false alarms with a target vehicle spaced 100 feet ahead of the radar; more of the main beam energy was blocked by the target vehicle and less energy was therefore radiated toward potential false alarms.

Test results also indicated that the effect of increasing the Doppler count delay threshold from 512 to 1024 did not reduce the number of false alarms significantly. At most, the onset of the false alarm was delayed 0.1 or 0.2 second; frequently there was no change at all, since threshold conditions for both 512 and 1024 cycles were often satisfied before entering braking regions. However, the change of Doppler count delay threshold was most apparent in curves where everything happened suddenly. The signal amplitude threshold was reached first, then ramp brake (N=512 Doppler cycles) and finally ramp brake (N=1024 Doppler cycles) approximately 0.2 second later.

Table 1 shows the frequency of occurrence of false alarms gathered for the three test courses with varying antenna beamwidths and maximum detection ranges. The numbers in the table represent the spread in frequency of occurrence of false alarms for the particular set of test conditions. The numbers shown in parentheses are the numbers of test runs for the test condition indicated.

Table 1 - False Alarms as a Function of Beamwidth and Maximum Detection Range

BEAMWIDTH	JOHN LODGE (Urban Expressway)				TELEGRAPH (Divided Main Artery)				TEN MILE (Two-Way Main Artery)			
	RCO - FT											
	100	150	200	300	100	150	200	300	100	150	200	300
2.5°		0-1 (5)	0-2 (7)	0-6 (8)		0-1 (5)	0-2 (6)	0-8 (6)		0-1 (5)	0-1 (6)	0-2 (6)
4.5°	1 (4)	0-3 (2)	2-8 (6)	18-37 (9)	0-2 (4)	1 (1)	1-3 (6)	5-22 (8)	0-3 (4)	9 (1)	0-5 (5)	2-13 (7)
10.0°	4-18 (4)	56-82 (5)	92-108 (7)	–	7-9 (2)	14-25 (2)	25-42 (4)	–	3-16 (3)	21-40 (2)	16-48 (2)	–

RAMP BRAKE (N = 512)

( ) NUMBER OF RUNS

R-182-6

The most significant false alarm problem for radar braking systems concerns overpasses on expressways and other main arteries. For the 4.5- and 10-degree antenna systems, significant main beam energy is backscattered to the radar. This is much less of a problem for the 2.5-degree antenna. False alarms from some overpasses are more severe than from others and there is no clear correlation of structure height or lane width with severity.

False alarms from fixed objects including overpasses are significantly reduced by use of narrow antenna beamwidth at the expense of increased antenna size, or by limiting the maximum detection range of the radar. The latter, of course, reduces the time available for braking on real targets.

Approximately eighty-three percent of the false alarms detected on the expressway were identified as related to overpasses, and about seventy-seven percent of false alarms detected on the divided main artery and two-way main artery were identified as related to roadside signs. Smaller percentages of false alarms were identified as related to parked or disabled vehicles, adjacent lane traffic, and guardrails. All the above classes of false alarms were subject to reduction as a function of beamwidth and maximum detection range.

Although the effect of atmospheric conditions such as rain or snow on radar performance was not one of the objectives of the experimental study, previous work indicated that CW Doppler radars operating at 22.125 and 36 GHz were susceptible to backscatter from medium to heavy rain. In the case of the 22.125 GHz radar, some improvement in performance in rain was possible by use of circular polarization which could provide up to 20 dB of suppression over linear polarization of rain-reflected signals. It is evident, however, that rain is a serious problem for the CW Doppler radar. Possible solutions include operating at a lower radar frequency, separation of transmitting and receiving antennas, or inhibiting the automatic braking function during heavy rain.

SECTION 4. SENSITIVITY ANALYSIS

The objectives of the sensitivity analysis are to evaluate the system cost-effectiveness of the 36 system configurations considered in the study and to examine the effects of changing system design parameters and the operational differences within each system. The methodology selected for the analysis was a computer simulation.

Accident Data Sources

The accident data sources representing six states and six counties were selected throughout the United States to provide as large a data base as practical, thereby reducing possible biases due to geographic, economic, and reporting agency influences.

The 5% sample sets from the states of Michigan and Texas for 1973 formed the basis for the accident simulation for the analysis mathematical model. These records from the various reporting agencies in the two states are stored on computer tapes at the Highway Safety Research Institute (HSRI) of the University of Michigan in Ann Arbor, Michigan. Each accident record on the tape contains, in some cases, more than 100 discrete pieces of data surrounding the accident. For example, it could describe a rear-end collision as having occurred at night, in the rain, at an intersection that had a stop sign and resulted in a single type "A" injury, i.e., the computer files are intended to reflect the total content of the report from each reporting agency.

For the analysis, it was required that these files be interrogated to determine not only the types of accidents that occurred but also other conditions that existed at the accident scene that may affect the operation of a radar brake system. The technique employed was to filter successively the accident files to compile accident types and conditions that were similar. Of the 22,531 total reported accidents in the Texas 5% sample file for 1973, 6,526 were reported as rear-end collisions. The data were further filtered by including only those that involved fatalities on dry straight roads. There are eight accidents involving fatalities which satisfied all of these conditions simultaneously. Similar filtering procedures and tabulating methods were used to screen out the overall accident set desired for the analysis.

The accidents that were investigated for inclusion in the mathematical model are by definition only those where radar-augmented braking might be beneficial. The accidents not included in the analysis were those where: the vehicle did not strike an object; the vehicle was backing up; pedestrian/bicycle accidents that involved the sides and back of vehicles; and all sideswipe accidents. The accident model also does not adjust for costs assigned to unreported acci-

dents. Information on these accidents was not sufficiently available to include their effects in the sensitivity analysis.

The states of Michigan and Texas contain 13,055,437 or 10.41% of the registered vehicles in the U.S. (125,420,876) for 1973. This proportion was used to extrapolate the benefits found in the sample set to the U.S. vehicle population. To test the representation of the sample set, several extrapolated accident types and circumstances were compared with those found in "Accident Facts," 1974 edition (1973 accidents). The forecast of fatalities and injuries revealed that the probability of more than two fatalities or more than five injuries occurring in a single accident was three sigma events. Where accident total exceeded these values, the mathematical model limited the count to the three sigma value. While it is expected that these accidents will happen, it was felt that there were insufficient data available to justify their analysis. The definition of injury by the National Safety Council is different from the one used for the model. The NSC count is only for those who were disabled beyond the day of the accident, whereas the Michigan-Texas results include all levels of injury. The largest difference in comparing the model forecast and the NSC data is for the total number of accidents in the U.S. for 1973. This difference is unexplained. Forecasts for total accidents based on other data sets have yielded results similar to those shown from Michigan-Texas. It was felt that the NSC estimates may include an adjustment for unreported accidents. The comparison of accident types by percentage was judged to have good results; however, the greatest difference is shown for angular collisions. For this accident type, the NSC definition is unclear and its count of "other" accidents probably contained those that counted as angular in this study.

System Cost-Effectiveness Analysis

System Configurations Considered

The following system parameters were considered for evaluation by the sensitivity analysis:

- Radar range: 100, 200, and 300 feet
- Brake system activation method: automatic and semi-automatic (driver initiated)
- Brake system type: standard design and with anti-lock
- Radar recognition delay (number of Doppler counts) : 23, 11.5, and 0 feet
- Low velocity system cut-off: 10 mph

The combinations of these parameters resulted in a total of 36 system configurations. In general, the systems shown are in ascending order of expected benefits; i.e., as range and braking effectiveness are increased and activation time constants are reduced, one would expect that more accidents would be reduced or prevented.

Five accident classifications where a radar brake system might be beneficial were considered in the study. These are: rear-end, head-on, angular, bicyclist/pedestrian, and fixed objects. These classifications were further grouped into radar target sizes as follows:

- Rear-end, head-on and angular collisions—target size medium or large determined as a function of known frequency of occurrence for vehicle-to-vehicle impacts in the accident report for 1973.
- Bicyclist/pedestrian and fixed object collisions—target size small for all accidents. Bicyclists and pedestrians naturally fall into this category, and fixed objects were also assigned a small cross section since accident data did not provide a better determination.

For the automatic activation of braking, a time constant of 0.1 second was used as the time required to bring the brake pressure up to maximum. The time constant used for the semi-automatic (driver activated) system was 0.9 second. This was selected for an average driver in the population given if he were to be confronted with a surprise situation.

The types of brakes included in the analyses are current standard design and anti-lock augmented systems. For the standard brake, coefficients of friction for the dry, wet, and icy surfaces considered were 0.7, 0.4, and 0.15 g's, respectively. The effectiveness of an anti-lock subsystem on accident reduction was modelled in the computer simulation only on the basis of shortening stopping distances under certain road surface conditions. While it is recognized that the vehicle stability offered by a four-wheel anti-lock is a major accident preventive factor, a method for including this parameter in the accident statistics model was not available. As a result, the anti-lock feature was modelled as providing a reduction in stopping distance (over the standard locked-wheel

brakes) only. The anti-lock improvements on stopping distance were taken from published reports as follows: no improvement on dry, +10% on wet surfaces, and +15% on icy surfaces.

The radar recognition range delays of 23, 11.5, and 0 feet were included to estimate the trade-offs in benefits when providing for reduced false alarms and intermittent targets.

Benefit Analysis

To estimate accumulated benefits due to reduced accident costs on a per vehicle basis over its expected lifetime, the sensitivity analysis utilizes the following factors:

- The cost to society for fatality, injury, and property damage due to motor vehicle accidents.
- The average lifetime of a motor vehicle in the current accident environment.
- A utility schedule that relates the exposure of a vehicle to accidents over its lifetime.
- A discounting method to account for the "time" cost of money over the vehicle lifetime.

The monetary values used for the savings ascribed to reduced fatality, injury, and property damage supplied by NHTSA for this study are:

Fatality	$242,000
Injury	7,000
Property Damage	360

To estimate the operational lifetime of a motor vehicle, information from the Motor Vehicle Manufacturers Association (MVMA) was used. From these data it was determined that an "average" vehicle would have a useful lifetime of nine years. No effort was made to extend this value because of recent price increases or other factors such as the current energy crisis that are expected to result in people keeping their cars longer. In general, any increase beyond a nine year lifetime would not impact on the results significantly due to the low utilization of older vehicles and heavy discounting of long term cash flows.

As might be expected, the utility of a vehicle changes over its lifetime. For example, five-year-old vehicles (1968) are involved in approximately 9% of the motor vehicle accidents. Five-year-old vehicles are shown to comprise approximately 9.25% of the 1973 vehicle population. The ratio of the percent involvement to percent in the population is the utility of the vehicle during its lifetime. This factor was intended to account for the relative heavy use of newer vehicles to adjust the expected benefits to a changing exposure condition.

The final consideration in estimating benefits for each radar brake system considered is the discounting of the flow of values over time. This procedure is equivalent to calculating the net present value (NPV) of monetary payments over time. It is:

$$NPV = \$P \sum_{i=1}^{N} \frac{1}{(1+i)} N$$

where

P=payment size

i=interest rate

N=number of years for payment, P

Computer Simulation Model

The simulation model used for the sensitivity analysis is shown in outline form in Figure 3. In general, the model can be viewed as having three distinct components; the accident data base, a radar evaluation process, and a system evaluation component.

The accident data base was built by using the information as discussed previously. The details of the accidents necessary to the sensitivity analysis were stored in cumulative probability distributions. The computer was used successively to draw a random number to "generate" an accident for evaluation and benefit assessment. After the accident type was established, a random number was used to determine the road surface conditions, using the dependent cumulative probability distributions.

The process of drawing random numbers and successively entering dependent probability distributions was repeated until an accident had been simulated. The final step in the process was to establish the velocity preceding the accident given the accident type and its severity. The information available at this point in the model includes the following for further analysis:

- Accident type
- Road surface condition
- Road geometry
- Target size
- Initial velocity
- Number of people killed or injured in the accident

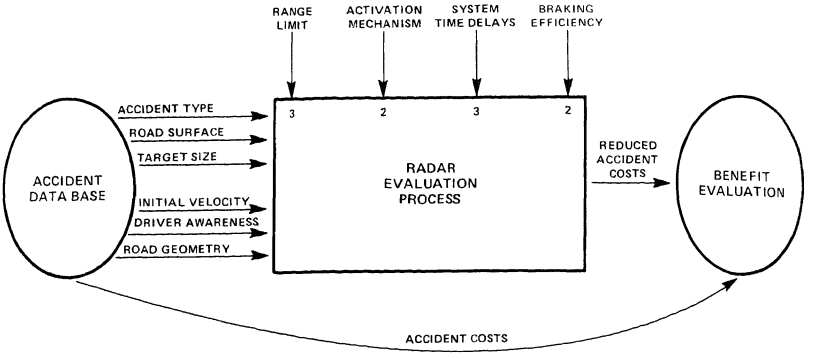

Figure 3. Simulation Model for the Sensitivity Analysis

In general, the accident simulation used dependent probability distributions throughout. The output of the accident data base serves as the input to the radar evaluation process.

The final portion of the model—the benefit evaluation—tallied the results from the radar evaluation process. In accidents where the initial velocity was reduced to zero, all of the original accident costs were counted as benefits. For accidents where the final velocity was non-zero, a statistical estimate of benefits was made. For property damage it was concluded that no benefit could be gained if the vehicle struck the target. No assessment was made for the effectiveness of energy absorbing bumpers. The inclusion of these benefits was beyond the scope of this analysis.

Results and Discussion

The results of the sensitivity analysis for the 36 system types are shown in Figure 4. The total benefit is expressed on a per vehicle basis accumulated over an average lifetime of nine years. For illustrative purposes, the total benefits are displayed by the components derived from accident prevention (no impact) and from accident severity reduction (reduced velocity at impact). The benefits shown are the most that society would be willing to spend over the vehicle lifetime and still have a cost-effective system. It is assumed these costs would include initial purchase, maintenance, repair, and replacement in the event of frontal impact.

Systems 1 and 36 represent the least beneficial and most beneficial combination of system parameters, respectively. The component of total benefit attributed to accident reduction is seen to range from 20% for System 1 to 12% for System 36. For all the systems evaluated, the benefits estimated from reduced accidents fall in approximately the same range of 12% to 20% of the total.

The total benefits described above are also inclusive of values gained from accident prevention and reduction on curved roads and or during rain conditions. The total benefits also reflect potential degradation due to the increased time constant used for driver activated systems when certain accidents are known to involve drinking drivers. For the curved road accidents, the contribution to total benefits varies between 4% and 8% for the 36 systems evaluated. This is somewhat higher than the population of curved road accidents of about 2.5%. It is estimated that the higher benefits in curves are due to the slightly higher accident costs associated with these accidents. The contribution to total benefits of accidents occurring in the rain varies from 12% to 15%. This is somewhat lower than the incidence of rain, given that the road is wet (about 18%). It is estimated that this result is due to the increased stopping distance for wet road surfaces. The effect of alcohol on driver reaction time downgrades the potential benefits of the semi-automatic systems by 10% to 15%. This reduction was measured by making a separate computer

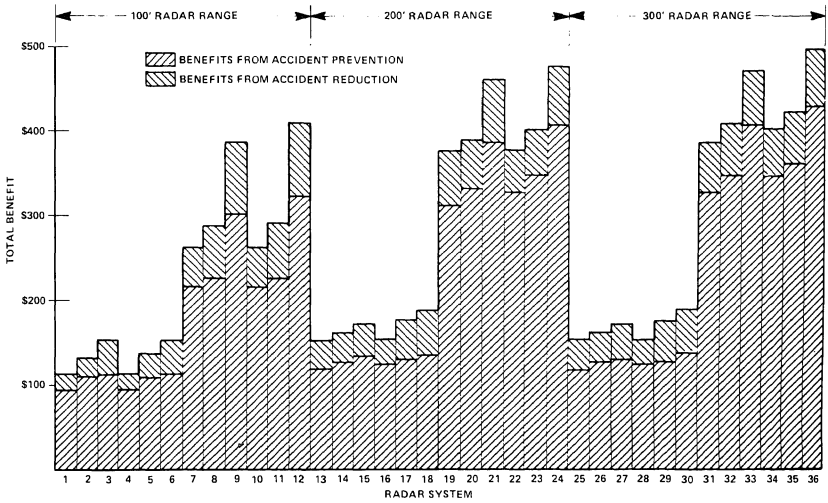

Figure 4. Estimated Total Benefit to Society (Per Vehicle Over Its Lifetime) vs Radar System Configuration

run and assigning all drivers a nominal reaction time of 0.9 second.

The sensitivity of total benefits to the parameter range can be seen by comparing every 12th system in Figure 4. Comparing Systems 1, 13, and 25, the total benefits of $114, $156, and $160 are shown, respectively. The incremental benefit gained by increasing range to 200 feet and subsequently to 300 feet is 37% and 2.6% for these systems, respectively. For all the systems shown, the incremental benefit from increasing range from 100 to 200 feet varies between 13% and 42%. As the range is increased from 200 to 300 feet, the incremental benefit varies between 0% and 5.5%. In terms of dollar benefit, the increase of range from 200 to 300 feet is worth at most $20. An initial conclusion is that if it costs more than $20 to increase range from 200 to 300 feet, it would not be a cost-effective decision to do so.

Similar comparisons can be made to determine the benefits for other system parameters: semi-automatic vs. automatic, with and without anti-lock, and radar range delays.

In terms of accident prevention, the performance of the 36 radar system concepts are shown in Figure 5. The percentages shown reflect those accidents in the data set that were determined to have stopped behind the target and are extrapolated onto the U.S. accident population. The distribution of benefits from accident prevention is similar to that of dollar benefits shown in Figure 4. The data show that between 8% and 25% of all accidents that occur annually in the U.S. could be presented if all vehicles were equipped with a radar braking system.

The potential benefits derived from saving lives in the U.S. accident population through utilizing either System 8 or 20 is illustrated in Figure 6. The figure shows the annual fatality reduction by accident type and also shows the expected increased benefit from using a 200-foot-range radar (System 20) over a 100-foot-range (System 8). The overall reduction in fatalities on an annual basis for the U.S. accident population by using System 8 or 20 is 6,000 and 9,800, respectively.

From the above discussion, an automatic radar augmented system having a detection range between 100 and 200 feet and a range delay detection of 11.5 feet appears most cost-effective.

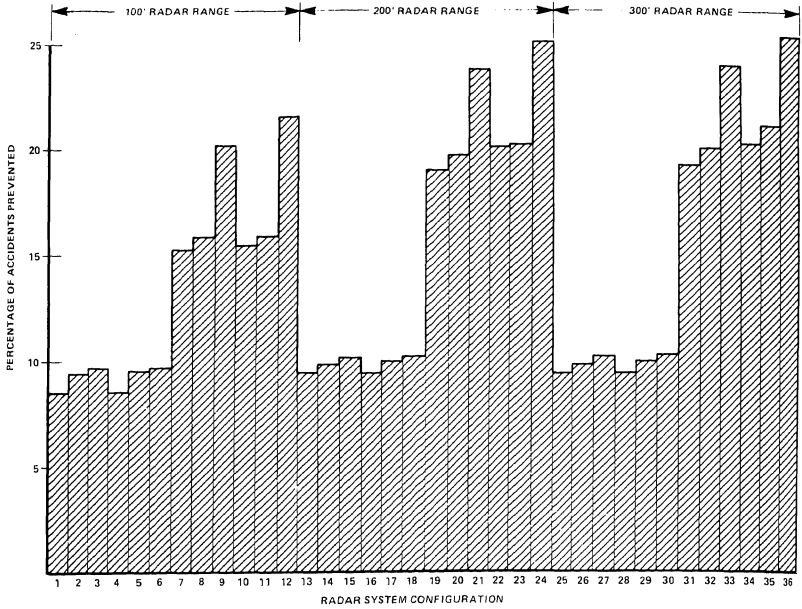

Figure 5. Estimated Percentage of Accidents Prevented Annually vs. Radar System Configuration

SECTION 5. INTERPRETATION OF RESULTS

The results of the target discrimination study and the sensitivity analysis must be mutually assessed to establish realistic bounds on performance parameters of a workable system. The first priority requirement which sets the bounds upon system types to be reviewed is that the false alarm rates must be very low, approaching zero for automatic braking operation.

Maximum Detection Range

Experimental results clearly indicate that false alarm is primarily a function of the radar range cutoff (RCO) and antenna beamwidth. Further, the frequency of false alarms was unacceptable for a 200-foot RCO or greater even in conjunction with the narrow-beam antenna. Test results also indicated that, with a 100-foot RCO, virtually all false alarms encountered can be eliminated. Therefore, for a system to contain false alarms to a tolerably low level, a 150-foot RCO must not be exceeded. The persistent false targets encountered during the 150-foot RCO road tests were for the most part representative of geometric situations which can be overcome by control law refinements of the system.

Threshold Delay

Although threshold delay appeared to exhibit secondary effects on false alarm activity in the road tests, the response of a zero delay system was not tested for comparison. The susceptibility of such a hair-trigger system to false alarms could only aggravate an already sensitive condition; therefore, some threshold delay should be employed in the system.

System Benefits

Applying the constraints of RCO and threshold delay discussed above, radar systems having an RCO

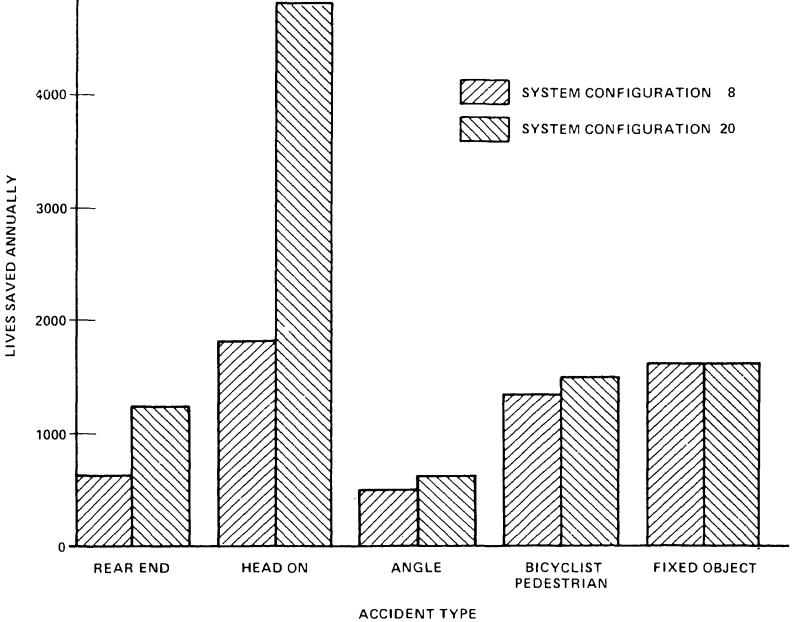

Figure 6. Estimated Annual Savings in Lives vs. Accident Type

of 200-feet or greater and zero threshold delay can be eliminated from consideration. Furthermore, the benefits of the automatic system far exceed those of the semi-automatic system. Therefore, the automatic system is established as the selected mode.

In this study it was assumed that, under all braking situations, the vehicle path was sufficiently contained during stopping to avoid causing satellite accidents. Thus, the benefits of anti-lock brakes are understandably unimpressive over those of standard brakes. This is probably deceptive because only the stopping distance improvement factor was entered in the computer simulation, while the major safety advantage of anti-lock is in maintaining vehicle stability during hard braking.

The sensitivity analysis also disclosed that the benefits between straight and curved roads and rain or no-rain operation were small contributors to the overall benefits. It would therefore seem economically feasible to accept a degraded or even inhibited mode of operation under the above conditions if significant operational features could be gained in other areas such as false alarm suppression.

Adopting the interpretative logic discussed above, system performance requirements and specifications are developed. The system performance specifications are shown in the next section.

SECTION 6. PRELIMINARY SYSTEM PERFORMANCE SPECIFICATION

Type of System: Automatic/Noncooperative

Radar Subsystem:

Modulation: Pulse, Diplex, Interrupted CW Doppler

Frequency: 35 to 36 GHz

Antenna Size: Up to 10 inch parabolic reflector

Beamwidth: 2.5 degrees to 4.0 degrees

Radome: Material with low dielectric constant and resistance to impact from small stones and/or gravel

Signal Processing: Digital

Delay Threshold: Time or range delay

Self-Test Capability: Continuous monitor

Detection Range: 100 to 150 feet with measurement accuracy of ±10%

False Target Detection: Zero for 100 foot or very low for 150 foot

Rain: Without false alarm up to 16 mm/hr (system inhibited for heavier rain)

Control Subsystem:

Relative Closing Velocity: 0.5 to 110 mph

Vehicle Velocity for Initiation of Braking: 10 mph minimum

Steering Angle Inhibit for Sharp Turns: ±2.5 degree front wheel angle (corresponds to 200 foot turning radius)

Throttle Inhibit: During automatic braking

Brake Pedal Override: Inhibits automatic braking

Braking Subsystem:

Type of Control: Automatic

Brake System Response: 0.2 second to reach 100% braking

Power Requirement: 12 vdc @ 2 amperes during operation
12 vdc @ 5 amperes peak maximum during brake actuation

Size: Compatible for installation on subcompact to full-size passenger vehicle

Weight: 15 pounds maximum

System Reliability: 1000 hours mtbf (in normal operation)

ABSTRACT CITATIONS

NHTSA accession number — HS-013 124

Title of document — **MAXIMUM BRAKE PEDAL FORCES PRODUCED BY MALE AND FEMALE DRIVERS**

Abstract — The object of this research was to obtain data concerning the maximum amount of brake pedal force that automobile drivers were able to sustain over a period of ten seconds. Subjects were told to apply the brakes in the test car as they would in a panic stop, and to exert as much force as possible on the pedal over the entire ten second test period. A total of 84 subjects were tested, including 42 males and 42 females. The results indicated that there is a wide distribution of values which characterizes the pedal force that the subjects were able to generate. Male subjects produced generally higher forces than did females. Over half the women tested were unable to exert more than 150 lbs. of force with either foot alone, but when both feet were applied to the pedal, force levels rose significantly.

Personal author(s) — by C. R. VonBuseck
Corporate author (or author's affiliation) — General Motors Corp.
Publication date; pagination — 1973? ; 18p
Supplementary note — Excerpts from Maximum Parking Brake Forces Applied by Male and Female Drivers (EM-23) BY R. L. Bierley, 1965, are included.
Availability — Availability: Corporate author

NHTSA accession number — HS-013 165

Title of document — **FRICTION MATERIALS, THEIR CHARACTERISTICS AND METHODS OF USE IN BRAKES AND CLUTCHES**

Abstract — Properties of woven cotton, woven asbestos, sintered methods, and cerments are given. Reasons for wear and brake fade are described. Different types of brakes and clutches are summarized.

Author statement — by Anonymous
Journal citation — Publ: Engineering Materials and Design
Publication date — 1973
Availability — Availability: Engineering Materials and Design v17 n4 p13-7 (Apr 1973)

HS-019 506

A RECENT HISTORY OF ACCIDENT INVESTIGATION AND DATA ANALYSIS

The history and progress of accident investigation and data analysis is traced from the first Collision Investigation Methodology Symposium held in 1969, in which various agencies and organizations concerned with highway safety were convened to determine state of the art of collision investigation and data collection, and to set goals and requirements for the future. The symposium stated goals and requirements and made recommendations for future work in several areas: identifying collision data users' needs; reviewing and reporting state of the art collision investigation methodology; identifying gaps and deficiencies in matching available data against users' requirements; reporting on new ideas and applications of technology to collision investigation to enhance usefulness of data produced; and producing proceedings of the symposium and aiding communication among present and future investigators. Accomplishments in accident investigation and data analysis since the symposium are described in both positive and negative aspects. Useful computer simulation techniques for accident reconstruction have been developed, and the use of such indices as the Abbreviated Injury Scale and the Collision Deformation Classification has been broadened, attaining greater uniformity in their interpretation. The multilevel approach for data collection to provide useful data in a cost effective way has been established, and use of statistical methods in study design and in data analysis has been expanded. Moreover, a nucleus of trained and experienced personnel in the highway safety field has been developed. On the negative side, progress in the study of accident causation has been limited, only recently initiating a system to collect a uniform sample of data on a national scale. Except in limited team areas, communication channels for dissemination of data to police, physicians, and the public which would encourage their cooperation in investigations have not been established. Only a small sample of accidents with medically reported injury data has been collected despite the fact that police reported injury data have been found virtually useless. Improved methodology and accomplishment in each of these areas and the establishment of new directions for future highway data collection and analysis programs are stated as goals for the future.

by John W. Garrett
Calspan Corp.
Publ: HS-801 979 (ZQ-5731-V-1), Motor Vehicle Collision Investigation Symposium Vol. 1: Proceedings, 1976 p52-9 1976
Availability: In HS-801 979

HS-019 507

STATUS OF PRESENT ACCIDENT DATA SYSTEMS

The status of present accident data systems is reviewed with respect to needs for improved accident data, factors impacting data system design, objectives of data systems, and current efforts. Six needs for accident data improvement are stated: identification of problem areas, assessment of proposed and existing countermeasures, support of highway safety legislation, and periodic trend data and research data bases. Not all of these needs can be satisfied in a cost-effective way, but the needs are seen as influential in determining data input and output from given systems. Factors impacting data system design (quantity of data, sample size/design, collection mechanism, data elements, sources, quality control, processing and analysis, and output requirements) are considered in interaction with data needs to determine how a system will look and how it will respond. Reasonable and viable objectives proposed for accident data systems are stated in terms of data needs as assessed against requisite data system design factors: to provide nationally representative data and related mathematical and statistical analyses to support the development and evaluation of national motor vehicle and highway safety programs, including cost-effective evaluations. Major current and development efforts to provide improved accident data analysis are described in discussion of the status of present systems: research activities such as the Restraint Systems Evaluation Program (RSEP); National Accident Sampling System (NASS); Pedestrian-Bicyclist Accident Data Sampling and Analysis Program (PADSAP); Fatal Accident Reporting System (FARS); and National Accident Reporting System (NARS).

by Marie D. Eldridge
National Hwy. Traffic Safety Administration, Office of Statistics and Analysis, Washington, D.C.
Publ: HS-801 979 (ZQ-5731-V-1), Motor Vehicle Collision Investigation Symposium Vol. 1: Proceedings, 1976 p60-75 1976
Availability: In HS-801 979

HS-019 508

GOVERNMENT SPONSORED ACCIDENT INVESTIGATION PROJECTS

An overview of government sponsored field accident investigation projects now underway identifies and discusses major studies supported by NHTSA, discusses pros and cons of the present system of accident studies, and describes attempts to improve on the system particularly in transition from individual, limited-scope special studies to a nationally representative accident data collection system as a goal. Current accident investigation studies concern vehicle braking methodology, injury causation, restraint system evaluation, driver behavioral errors, evaluation of Federal Motor Vehicle Safety Standard No. 121 (braking), truck accident methodology, motorcycle accident causation and injury severity, and bicycle accident causation and injury severity. Other studies are contracted on further development of the Simulation Model of Automobile Collisions, alcohol-involved accidents, and accident investigation teams. Pros of the present system of studies are: responsiveness to in-house operational needs; the priority problems of NHTSA; timeliness; and superiority of level of detail and quality of data resulting. Cons of the system of studies are: lack of systematic character in unrelatedness of studies; inability to yield statistically valid estimates which may not be nationally representative; unresponsiveness to new or unforeseen requirements; and inadequate geographic coverage. A solution to the problems seen in the characterization and results of the studies is proposed by putting the NHTSA field accident investigation program on a probability sampling basis that will assure study of a representative set of accidents and will yield statistically valid results, as in the National Accident Sampling System (NASS) scheduled for implementation within three to five years. Before NASS implementation, measures to improve the NHTSA

program are suggested: retain problem orientation; institute probability sampling techniques; and implement the National Crash Severity Study to obtain nationally representative, quantitative measures and relations of crash severity and injury severity on an interim basis.

by William E. Scott
National Hwy. Traffic Safety Administration, Accident Investigation Div., Washington, D.C.
Publ: HS-801 979 (ZQ-5731-V-1), Motor Vehicle Collision Investigation Symposium Vol. 1: Proceedings, 1976 p76-87 1976
Availability: In HS-801 979

HS-019 509

FATAL ACCIDENT REPORTING SYSTEM AND NATIONAL ACCIDENT REPORTING SYSTEM

Two accident reporting systems, the Fatal Accident Reporting System (FARS) and the National Accident Reporting System (NARS), and their joint use are described. FARS sources for data include police accident reports, driver license information, vehicle registrations, and highway department and vital statistics files. The NARS processing program examines data looking for element errors, inconsistencies, or questionable entries and produces a computer listing of data indicating problems (if any) found. After verification and validation, the data are put on a master file which is subjected to routine monthly analyses and can undergo specialized statistical analyses by trained personnel to be reported to the highway safety community. The NARS program is similar to FARS and will in the future be incorporated into one overall system based on police-report information to give a detailed picture of accidents on the nation's highways; it samples accidents occurring rather than selecting all accidents with fatalities as in FARS. Presently the NARS is being used to investigate reporting thresholds, reporting jurisdictions, filing methods used, and universe parameters needed to construct an adequate sample design. The combination of FARS and NARS will provide a national accident picture by collecting information on all fatal and a subsample on nonfatal accidents, with emphasis on verified and validated data. Plans to launch a study on national crash severity are also outlined as a prototype construction for a full-scale National Accident Sampling System (NASS). The NASS will feature uniform definitions throughout all reporting jurisdictions, quick reporting, easy availability of data, and regular reporting of basic information in the form of descriptive statistics.

by David R. Morganstein
National Hwy. Traffic Safety Administration, Washington, D.C.
Publ: HS-801 979 (ZQ-5731-V-1), Motor Vehicle Collision Investigation Symposium Vol. 1: Proceedings, 1976 p88-109 1976
Availability: In HS-801 979

HS-019 510

PEDESTRIAN/BICYCLIST ACCIDENT DATA SAMPLING AND ANALYSIS PROGRAM (PADSAP)

The Pedestrian/Bicyclist Accident Data Sampling and Analysis Program (PADSAP) is an accident data collection and analysis system based on a national probability sample design; it provides periodic descriptive and causal statistics on the national population of pedestrian and bicycle-motor vehicle accidents. PADSAP system development is proceeding in three pha system design (specification of data requirements and data lection mechanism, development of the sample des development and analysis of alternative sample sizes, deve ment of data processing and analysis specifications inclu system output, and development of an implementation plan pilot testing and phasing into full-scale operations); pilot of system design (test operability of all system aspects produce usable output on accidents); and full-scale imple tation pending results of the pilot test. Data acquisition qu and procedures are seen as the most problematic aspect development of the accident data system, with dependenc communication and liaison that can be maintained with collection agencies indicated. Aspects of PADSAP curre being evaluated in the pilot test phase include: degree cooperation obtainable from various types and sizes of p agencies; quality and consistency of data obtainable f these agencies; and magnitude of the liaison effort involve working with a large number of police agencies. Experienc date indicates that a high degree of cooperation can be pected from police agencies except those in large cities (du economic and personnel commitment problems).

by Glenn G. Parsons
National Hwy. Traffic Safety Administration, Washington, D.C.
Publ: HS-801 979 (ZQ-5731-V-1), Motor Vehicle Collision Investigation Symposium Vol. 1: Proceedings, 1976 p110-7 1976
Availability: In HS-801 979

HS-019 511

OFFICE OF STATISTICS AND ANALYSIS PLANS FOR A NATIONAL ACCIDENT SAMPLING SYSTE

Current thinking and plans within the Office of Statistics Analysis of NHTSA relating to the development of the tional Accident Sampling System (NASS) are reviewed. N objectives are stated as a system which would select, proc and analyze data which: assist in producing accurate estim of national totals, trends, causes, and consequences highway accidents; are a basis for valid national assessm of effectiveness of existing safety countermeasures and s dards; provide accurate, detailed description of all phase accidents to enable advancement, evaluation, and design timization of new safety countermeasures; and provide clir information on accident causation, injury mechanisms, new investigative techniques through in-depth investigati Prerequisites for NASS success in these objectives are propriate probability sampling of accidents and minimiza of sampling, nonsampling, and analytical errors within bu constraints. NASS structure will feature integration with Fatal Accident Reporting System, the National Accident porting System, and a continuously sampling subsystem lecting data on: preexisting conditions, collision causation, lision severity including velocity changes, discernable inj and contact points, injury treatment and convalescence, precrash and crash countermeasure potential. A q response subsystem will be used to carry out special stu for in-depth capability efforts on a nationally represent basis, coordination of evaluation of demonstration proj provide quick feedback for evaluating new countermeasu and measure impact of changes in environment (such as e gy crisis). Suggestions are also made for ancillary stu management and quality control of the system, data proces techniques, and legislative/rulemaking support. Implement of NASS within three years is stated as a goal follo

development of NASS investigation teams, management structure, quality control, and data processing systems. Implications of development of the NASS system include: data users' benefits, accident research orientation, community involvement, and conceptual development.

by Charles J. Kahane; Scott N. Lee; David R. Morganstein
National Hwy. Traffic Safety Administration, Washington, D.C.
Publ: HS-801 979 (ZQ-5731-V-1), Motor Vehicle Collision Investigation Symposium Vol. 1: Proceedings, 1976 p118-31 1976; 3refs
Availability: In HS-801 979

HS-019 512

EXPOSURE DATA NEEDS

The measurement of driving exposure -- all the hazardous situations that the driver encounters during a period of interest -- though virtually impossible to obtain, is necessary to predict the numbers and types of accidents that will result from that exposure. Absolute measures, such as vehicle miles of travel, gasoline consumption, hours of driving and numbers of trips, are more readily acquired than measures of induced exposure produced from estimates of relative risk for various groups of road users obtained from accident data. Exposure information must be measured in vehicle-miles using factors such as age and sex of driver, alcoholic and nonalcoholic drivers, road type, time of day, and vehicle make, model and year. Such measurement will assist in interpreting overall changes; improve traffic safety programs to change driver behavior; and help in road improvement programs. NHTSA's current intentions are the same as those stated in 1973 at a three-day symposium on driving exposure in Silver Spring, Maryland. The following points are stressed in the context of those intentions: NHTSA plans to collect exposure information as a part of the continuous sampling system activity of NASS (National Accident Sampling System), using the same groups to collect accident and exposure information; vehicle miles will be the exposure measure for the foreseeable future and a goal of the program will be to collect information in sufficient detail to classify vehicle miles by factors such as these mentioned above; research on other exposure measurement techniques and on a measure of pedestrian exposure will be undertaken; the implementation of exposure data collection will be tied very closely to implementation of NASS, and it will be three to five years before we can expect nationally representative exposure measurement.

by Donald F. Mela
National Hwy. Traffic Safety Administration, Washington, D.C.
Publ: HS-801 979 (ZQ-5731-V-1), Motor Vehicle Collision Investigation Symposium Vol. 1: Proceedings, 1976 p132-42 1976; 7refs
Availability: In HS-801 979

HS-019 513

USER DATA NEEDS

The final step in developing countermeasures to prevent injuries, fatalities and economic loss in motor vehicle accidents involves the interpretation of test or analysis results and projection of such results into the real world crash environment. Comparison of such results obtained from several systems permits finding the preferred system. To obtain likely benefits of alternative courses of action, a computerized benefits analysis model has recently been set up consisting basically of an exposure matrix containing relative frequencies of various crash situations, and an effectiveness matrix stating the likelihood of various levels of injury severity of each crash situation. Multiplication of the two matrices yields the numbers of levels of injury in the population. The exposure matrix must accurately reflect the total population, and the effectiveness matrix must state the likelihood of incurring various levels of injury with a given vehicle system in each significantly different crash situation. Very importantly, the exposure and effectiveness matrices must be compatible. Currently such programs as SMAC have had difficulty in determining the significant parameters and have lacked sufficient detail for accurate reconstruction. An inexpensive, accurate delta V recorder is available from the David Breed Corporation but must not be used to the exclusion of all others.

by James E. Hofferberth
National Hwy. Traffic Safety Administration, Washington, D.C.
Publ: HS-801 979 (ZQ-5731-V-1), Motor Vehicle Collision Investigation Symposium Vol. 1: Proceedings, 1976 p143-8 1976
Availability: In HS-801 979

HS-019 514

DATA COLLECTION AND ANALYSIS IN SAFETY DEMONSTRATION PROGRAMS

The Alcohol Safety Action Program (ASAP), one of the largest demonstration programs, illustrates some collection problems. Of three measures used to determine alcohol involvement in a crash, all present problems: Only about one half of the fatally injured drivers are measured for BAC; police officer judgments at the crash scene vary widely; and variables such as the reduction of the speed limit, which greatly lowered the number of night crashes, often make many proxy measures unreliable. Further, some traffic safety standards are difficult to evaluate because of a lack of criterion data and the use of improper evaluation techniques that do not incorporate dependence characteristics such as seasonality or the presence of cycle or trend components that violate various assumptions associated with the statistical techniques. The Box-Jenkins technique of discrete time series, however, allows one to forecast future movements based on relationships existing in the past by using a multivariate rather than a univariate approach. Inputs such as speed limits and DWI arrests can be varied and others expanded to examine any interventions to be hypothesized. STEP (Special Traffic Enforcement Demonstration Programs) results of an 18-month demonstration program conducted by the Takoma, Washington, Police Department illustrate the use of the Box-Jenkins technique as a potentially powerful analytic tool for evaluating impact measures affected by countermeasure programs.

by Terry Klein; Paul S. Levy
National Hwy. Traffic Safety Administration, Washington, D.C.
Publ: HS-801 979 (ZQ-5731-V-1), Motor Vehicle Collision Investigation Symposium Vol. 1: Proceedings, 1976 p149-70 1976; 2refs
Availability: In HS-801 979

new ideas or conjectures from which another learning cycle can begin. Broad needs for collision data are related to: evaluation of production safety systems; prediction of performance of proposed safety systems; identification of problem areas and evaluation of proposed solutions on a cost/benefit basis; estimation of human tolerance to impact; estimation of efficacy of existing safety standards; estimation of benefits of proposed safety standards; correlation of results of laboratory experiments with highway accident facts; evaluation of field trials; and validation of results from mathematical simulation models. A productive learning iteration based on effective design of an experiment or a sampling strategy to yield data from which meaningful inferences can be drawn is discussed as a problem-solving process. Planning concerns include decisions on what elements to observe, how to collect data, how much data are needed, who should collect accident data, and how should data be analyzed and evaluated. It is concluded that only the government has the resources for collecting and storing quality accident data in the quantities that subsequent analyses require. Criteria for planning and implementing data collection are suggested as: representativeness; sufficiency of sampling from the aspect of cost tradeoff and adequate quantities; quality of data related to accuracy and precision of observations and recording; limitations of some factors measurement and classification procedures; and need for complex estimates of single and combined effects.

by John D. Hromi
Ford Motor Co.
Publ: HS-801 979 (ZQ-5731-V-1), Motor Vehicle Collision Investigation Symposium Vol. 1: Proceedings, 1976 p171-80
1976; 13refs
Availability: In HS-801 979

... was
or vehicle
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; use, and property damage on roads and streets. It functions in areas of: coordination of vehicle safety activities, issuance and enforcement of mandatory safety standards, ministering notice of defect (recall) program, liaison with traffic safety agencies in other countries, and conceiving and funding road safety research and development. The Division organizes and executes a program of in-depth accident investigations and investigates and reports on cases involving possible defects. The Division investigations evaluate effectiveness of vehicle safety standards, determine need for new or revised standards, identify possible safety-related defects, generate data needed for research, and identify and determine the extent of a safety-related problem. The Division has organized and funded nine university Multi-Dimensional Accident Investigation (MDAI) research teams composed of specially trained physicians, engineers, psychologists, statisticians, and other accident reconstruction specialists and labora-

past 12 months, prepared 150 in-depth accident reports, and conducted 16 special investigations and 77 defect investigations. Major change in the present system of accident and defect data collection is not foreseen, but expansion of commercial vehicle coverage is predicted.

by James A. Bancroft
Ministry of Transport, Ottawa, Canada
Publ: HS-801 979 (ZQ-5731-V-1), Motor Vehicle Collision Investigation Symposium Vol. 1: Proceedings, 1976 p181-8
1976; 9refs
Availability: In HS-801 979

HS-019 517

ACCIDENT INVESTIGATION - THE ENVIRONMENT VIEWPOINT

Two problem areas associated with the environmental specialist's role in accident investigation are discussed: failure of the specialist to perform a timely scene analysis possibly compounded by failure to inform other specialists of his interpretations; and increased demands imposed by scientific advancement of the field of environmental studies. Scene analysis consists of finding all evidence generated at the scene, determining vehicle dynamics during the accident sequence, measuring and recording the evidence, and determining travel speeds, impact speeds, and velocity changes. Two accident cases are presented in relation to these analytical and communications tasks, emphasizing completeness and speed of investigation and reports as criteria for investigative quality. Most important data required include pre-crash driver inputs, driver analysis of post-crash environmental conditions, crash phase occupant kinematics, and pre-crash and crash phase mechanical malfunctions. Advent of sophisticated reconstruction techniques and computer program systems analysis data banks indicates another growing problem area in environmental investigation, that of collecting sufficient quality data to satisfy the needs of the advanced systems. Since the investigator may not be able to predict all data requirements in advance, documentation overkill is suggested as an interim solution.

by Donald L. Hendricks
Calspan Corp.
Publ: HS-801 979 (ZQ-5731-V-1), Motor Vehicle Collision Investigation Symposium Vol. 1: Proceedings, 1976 p189-207
1976
Availability: In HS-801 979

HS-019 519

INTERVIEWS 0MOTOR VEHICLE COLLISION INVESTIGATION0

Methodology and content for interviews used in motor vehicle collision investigations emphasize the basic interview directed primarily at determining what happened in the accident rather than interviews which investigate underlying psychological psychosocial factors. The basic interview is used to obtain a description of the events of the accident and the immediate causes of those events; it is short and structured in format to

format or sequencing, depending on the immediacy of data needs and the reactions of involved drivers. The Calspan interview technique emphasizes accident description first in order to obtain data while they are fresh with those involved and while they are able to be verified by observations. On-the-scene interviews are preferable to later interviews because the rate of refusal is lower and because drivers may have less consideration for their own culpability in the accident; on the other hand, the interviewer is handicapped by a lack of knowledge of physical evidence and other reported evidence which may subsequently be obtained, there are increased costs, and also a physical inability to reach many accident scenes before clean-up. The role of the interviewer as a harmless, sympathetic person who coincidentally and frankly takes notes or records the interview is also recommended.

by Dominic F. Morris
Calspan Corp.
Publ: HS-801 979 (ZQ-5731-V-1), Motor Vehicle Collision Investigation Symposium Vol. 1: Proceedings, 1976 p243-51 1976
Availability: In HS-801 979

HS-019 520

COMPUTER RECONSTRUCTION AND ACCIDENT SEVERITY

Two computer programs in current use for reconstructing accidents (Simulation Model of Automobile Collisions (SMAC) and Calspan Reconstruction of Accident Speeds on the Highway (CRASH)) are described, outlining the formulation of an objective measure of crash severity. SMAC simulates motions and interactions of two vehicles moving in a level plane, and calculates paths of vehicles before, during, and after collision, tire tracks left by each vehicle, damage to each vehicle, and the velocity change vector suffered by each vehicle during impact. The program is based on engineering mechanics principles and best available experimental data for tire forces and vehicle crush forces. The CRASH program directly applies principles of conservation of linear and angular momentum to the involved vehicles, and obtains velocities of the vehicles following impact by linearization of general equations for the stopping/spinning distance of a skidding vehicle. Velocities of vehicles before impact are then obtained from post-impact velocities by momentum conservation to equal velocity change but not absolute speeds. Principal advantages of both computer reconstruction programs are: uniformity among teams, accuracy of reconstruction, quality control of data, performance of hypothetical studies, and calculation of a quantitative, objective severity measure for diverse impacts. Severity measures in use include velocity change and equivalent stopping distance. The unimportance of absolute velocities in producing damage in a crash is demonstrated by analytical demonstration of kinetic energy changes among four crash-involved cars.

by Charles A. Moffatt
West Virginia Univ., Mechanical Engineering and Mechanics
Publ: HS-801 979 (ZQ-5731-V-1), Motor Vehicle Collision Investigation Symposium Vol. 1: Proceedings, 1976 p252-61 1976
Availability: In HS-801 979

electronic survey of the automobile accident scene's physical evidence with an electro-optical targeting system. An onboard minicomputer system performs a polar-to-rectangular conversion of the sighted evidence, and stores and plots it. This evidence, in numeric format, is submitted to the Calspan Reconstruction of Accident Speeds on the Highway (CRASH) program for a preliminary impact speed analysis. The CRASH results provide the basis for a Simulation Model of Automobile Collisions (SMAC) simulation run, which may be iterated to provide the most accurate reconstruction currently available by analytical methods. The minicomputer then provides a complete report, including scene sketch, CRASH and SMAC results and plots, and a police-style accident report. An initial prototype of this investigation concept has been developed and is undergoing initial field tests to determine the types of hardware most suitable to accomplish the investigation objectives.

by James P. Lynch
Calspan Corp.
Publ: HS-801 979 (ZQ-5731-V-1), Motor Vehicle Collision Investigation Symposium Vol. 1: Proceedings, 1976 p262-75 1976
Availability: In HS-801 979

HS-019 522

AUTOMATIC ITERATION OF SMAC 0SIMULATION MODEL OF AUTOMOBILE COLLISIONS0

Development and use of the START computer program to automatically run the Simulation Model of Automobile Collisions (SMAC) computer program from a minimum of input data and of the ITERATE program to optimize the input values of velocities to provide a best fit reconstruction to the available scene data are described as part of an effort to make the simulation/reconstruction SMAC system user-oriented to allow its operation by nontechnical users. The SMAC procedure requires punching a program deck of 14 input cards containing data on initial conditions, vehicle dimensional properties, control inputs, and vehicle structural crush properties, attaching appropriate job control cards, and running the program, with printed output providing displacements, orientations, velocities, and accelerations of each vehicle as a function of time together with damage patterns, vehicle damage indices, and velocity change experienced by each vehicle. This process is repeated with additional data and appropriate parameters adjustment until a reconstruction is obtained which is consistent with available scene evidence. In order to make the procedure easier and more objective, START and ITERATE routines are used. START generates the input cards from scene data furnished by the operator and runs the program automatically until both vehicles are designated at rest, then ITERATE compares predicted rest positions of each vehicle compared to their actual positions. If there is agreement within 5% the run is accepted and the program terminates, but if not the impact speeds of each vehicle are adjusted and the SMAC program rerun with these new inputs until an acceptable solution is obtained. The ITERATE routine as described is still being developed, but the feasibility of the approach is demonstrated through evaluating results of four accident reconstructions using the automated SMAC program. A limitation in operating an iterative reconstruction program of this type is cost, but fu-

HS-019 523

THE CRASH 0CALSPAN RECONSTRUCTION OF ACCIDENT SPEEDS ON THE HIGHWAY0 PROGRAM - A SIMPLIFIED COLLISION RECONSTRUCTION PROGRAM

Results obtained with a closed form reconstruction calculation (Calspan Reconstruction of Accident Speeds on the Highway (CRASH)) for several staged collisions are compared with measured responses, including definition of the reconstruction procedure, outlining derivations of the analytical relationships, and presenting results of sample applications of the computer program developed. CRASH use is for applications to cases in which reported evidence is not sufficiently detailed to justify application of the Simulation Model of Automobile Collisions (SMAC) computer program and/or to existing large bodies of case reports where the cost per case for analytical reconstruction is a primary consideration. Nine sample applications are presented and discussed, stressing shortcomings of each as a standard, well-defined, and representative accident. CRASH reconstruction of speeds and velocity changes at impact for cases involving offset frontal, rear side, frontal head-on, oblique side, perpendicular side, and trajectory impacts was considered good (within 12% accuracy at a cost of $1.00-$5.00 per case) considering the limitations imposed by measured value uncertainties and affecting conditions used in some staged collisions. Analytical relationships for damage (central , energy absorption) estimates escribed. The availability of the to generate detailed collision cial to the described development. An appendix presents a subroutine for analyzing spin.

by Raymond R. McHenry
Calspan Corp.
Contract DOT-HS-053-3-609; DOT-HS-053-3-658
Publ: HS-801 979 (ZQ-5731-V-1), Motor Vehicle Collision Investigation Symposium Vol. 1: Proceedings, 1976 p298-341 1976; 16refs
Availability: In HS-801 979

HS-019 524

CRASH VICTIM SIMULATION - A POTENTIAL AID FOR RECONSTRUCTION OF ACCIDENTS

The three-dimensional computer simulation of the crash victim developed by Calspan, providing predictions of dynamics of the crash victim either as a vehicle occupant or a pedestrian in response to the dynamic behavior of the vehicle during an accident, is described as another mathematical simulation model with potential for aiding in accident reconstruction. Major elements of the computer program include: the body dynamics model (in which equations of motion of various segments of the body are solved using dimensional and inertial data and the various forces that are computed which act on individual segtime history of the vehicle. Output from the program is controllable through input code and includes x, y, and z components of linear acceleration; velocity and displacement of each segment; joint angles and torques; segment angular acceleration, velocity, and displacement; location and force developed at vehicle contact points; and belt or inflatable restraint system loads. A preprocessor computer program called Generator of Occupant Data (GOOD) is used to aid the task of developing data sets for different size occupants. Good correlation has been obtained in comparison of predicted occupant response with experimental results, and the model has been used to analytically reconstruct 10 accidents. The reconstruction study included vehicle dynamics reconstruction using the Simulation Model of Automobile Collisions (SMAC) computer program to obtain an acceptable match with physical evidence contained in case reports and input of time histories of vehicle deceleration to the crash victim model to reconstruct responses of right front seat passengers based on reported vehicle interior contacts and damage and resulting injuries. The accidents were also subsequently physically simulated in accelerator sled tests matching closely the time history and direction of vehicle accelerations predicted by SMAC and in anthropomorphic crash test dummies to represent accident victims. Correlation between severity of injuries sustained in the actual accidents and those inferred from predicted responses and those measured for the test dummies was shown to be poor, although the sled tests tended to better indicate the expected general trend of greater injury severity with increased Head Severity Index. Many aspects of the simulations were consistent with the information of accident data reports, such as locations of occupant contacts with the interior and the general extent of deformation. The crash victim simulation model is judged impractical for reconstructing accidents on a routine, high volume basis due to the need for more specialized input data and the difficulty in its application and evaluation of results.

by Norman J. DeLeys
Calspan Corp.
Publ: HS-801 979 (ZQ-5731-V-1), Motor Vehicle Collision Investigation Symposium Vol. 1: Proceedings, 1976 p342-61 1976; 5refs
Availability: In HS-801 979

HS-019 525

STRUCTURAL MODELING AND COLLISION RECONSTRUCTION - AN ALTERNATIVE

A more detailed model of the crush properties of automotive structure (for a 1975 Chrysler standard size car) has been developed from experimental data for possible use in the Simulation Model of Automobile Collisions (SMAC) reconstruction program. The utility of the more detailed structural model could be demonstrated by comparing SMAC program runs using highly simplified vehicle structure parameters as currently stated and using an intrusion pressure function specifically tailored to the crush properties of a given vehicle. The method for easy generation of detailed intrusion pressure

functions is a process of: determining desired front end, side structure, and rear end cross sections from experimental data; expressing critical points on the cross sections as lines and planes through which the intrusion pressure function passes; and fitting a smooth surface to the lines and planes using a surface fit algorithm implemented by Fortran subroutine with rear function and real function operating on arrays describing the lines and planes. The validity of use of force/crush data is defended by an analysis of model sensitivity to impedance masses, nonlinear springs and dampers, and velocity. The Fortran subroutines suggested (and given in the appendix) can enable an evaluation of the current SMAC model with only minor changes to the computer program. If a change in the structural model portion of SMAC is indicated, the same technique used to develop the Chrysler structural model can be extended to other vehicles or vehicle types.

by Stanley E. Staffeld
Chrysler Corp.
Publ: HS-801 979 (ZQ-5731-V-1), Motor Vehicle Collision Investigation Symposium Vol. 1: Proceedings, 1976 p362-80 1976; 9refs
Availability: In HS-801 979

HS-019 526

EXPERIENCE IN CORNER DAMAGE CLASSIFICATION USING SAE J224a - COLLISION DEFORMATION CLASSIFICATION

Experience in corner damage classification using SAE J224a "Collision Deformation Classification" is described to illustrate the wide interpretations possible with the definitions provided. An analysis of codes used to describe damage in peculiar damage cases were conducted to determine the general extent of classification problems, showing that certain areas of coding revealed significant divergence in understanding of SAE J224a by different raters. These variances were summarized in an heuristic attempt to establish explicit guidelines to help avoid these areas of misunderstanding and implicit misapplication in the future. Vehicle deformation index (VDI) guidelines suggested are: (1) corner damage when produced by longitudinal or lateral force is simpler to classify if the force is applied perpendicular to the surface selected for general location, specifying extent and amount of contact damage; (2) corner damage where the principal force is more angular in nature requires a circumstantial interpretation; (3) when two or more adjacent zones are damaged with corner involvement the most descriptive damage classification character should be selected, considering area of first contact; and (4) deformation location code and specific horizontal location of deformation code should always be dependent on each other. A guideline for a sideswipe code is also suggested with appropriate criteria. Recommendations are made for developing and using a set of field-tested universal guidelines to go with SAE J224a to improve classification of vehicle damage.

by J. Robert Cromack
Southwest Res. Inst.
Publ: HS-801 979 (ZQ-5731-V-1), Motor Vehicle Collision Investigation Symposium Vol. 1: Proceedings, 1976 p381-98 1976
Availability: In HS-801 979

HS-019 527

COLLISION DEFORMATION CLASSIFICATION PROBLEM AREAS

Four problem areas related to the collision deformation classification (CDC) method of accident data handling are discussed: use of multiple CDC ratings in a single continuous impact sequence; recording vertical components of force in conventional direction of force analyses; recording lateral displacement of the top in rollover sequences; and use of the FYEN and FZEN code designations. Use of CDC guidelines in a single continuous impact sequence has been problematic when multiple damage patterns are produced (both frontal and side impact damage characteristics resulting from vehicle rotation following initial contact). It is suggested that use of more than one CDC rating code be allowed to enable analysts to describe accident results accurately. When recording vertical components of force in conventional direction of force analyses, there is presently no provision in the CDC structure for recording directions of force which have a pronounced vertical component; it could be made by using alphanumeric characters. Similarly, provision is not presently made in the CDC structure and is recommended for measuring and recording lateral displacement of the top in rollover sequences. Use of the FYEN and FZEN code designations should be made when appropriate even though listings for these code combinations are not presently in the CDC structure. Illustrations of the damages described in the four problem areas are presented, stressing the effects these displacements and damages could have on vehicle occupants and on evaluating their injuries by cause and intensity.

by Donald L. Hendricks
Calspan Corp.
Publ: HS-801 979 (ZQ-5731-V-1), Motor Vehicle Collision Investigation Symposium Vol. 1: Proceedings, 1976 p399-410 1976; 1ref
Availability: In HS-801 979

HS-019 528

USE OF MEASUREMENT DATA

Two general categories of highway and traffic safety data or measurement are discussed: global/general data elements and specific/research data elements. General elements are used mostly in descriptive statistics of accidents and traffic safety (annual total of traffic fatalities and vehicles on the road), while specific measurements quantify some phenomena of the accident picture. It is suggested that increased use of such research data elements, especially as relating to the collision phase of the accident picture, can be readily obtained to support rule making and vehicle design. Sources of the data can include police investigations or other investigations not conducted in depth. Since collecting measurement data from these sources offers considerable savings in cost, the relationship of savings with reduced scope of investigation should be considered in formulating objectives of investigation and data use. Use of multiple data from low intensity investigations can offset the limitation imposed by reduced scope in single cases, by considering correlations between specific variables using multidimensional statistical methods. Use of simple hardware such as a crash recorder or the velocity change meter is discussed as a means of routinely collecting such data for accumulation,

mechanic with recommendations for repairs. The system also provides the mechanic and the customer with a hard copy printout of all tests performed, the actual vehicle specifications, and all recommended repairs. The system is also capable of being expanded by the addition of both software and hardware packages to interface with new vehicle systems and different types of vehicles. Typical uses of Autosense include tuneups, periodic routine maintenance, customer complaints, predelivery vehicle preparation, and used car presale preparation. Evaluation of several hundred Autosense systems currently operating in the field has proven their reliability and cost-efficiency in these applications. The system consists of a vehicle instrumentation harness with a unique clamp-around current sensor; the autosense console containing the printer, integrated diagnostic unit, and an optional exhaust gas analyzer; and a hand-held controller containing the displays and keyboard.

by K. Parker; P. D. Miller
Hamilton Test Systems, Inc.
Rept. No. SAE-760144; 1976; 13p
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 531

A METHODOLOGY FOR ASSESSING AND CLASSIFYING TRAFFIC ACCIDENT CAUSES

A methodology for assessing and classifying traffic accident causes developed and assessed by the Institute for Research in Public Safety (IRPS) at Indiana University involves collection of accident data on three levels of detail: baseline data on the study area (including police reports of all traffic accidents); greater detail on a subset of individual accidents (about 25%) is sought through on-site investigations by IRPS technicians (including driver interview(s), vehicle condition inspection, and examination of accident environment for physical evidence and deficiencies); and in-depth investigations involving additional human, vehicular, and environmental inquiries by a team of professionals. The tri-level IRPS method culminates with an analysis and conclusion session with participation by interdisciplinary personnel where the group determines which factors will be listed as accident causes or severity increasing factors. The IRPS causal factors categories include human direct causes, human conditions and states, vehicular factors, and environmental factors, with each category able to be broken down into finer subcategories: human direct (nonaccident, critical nonperformance, recognition errors, decision errors, performance errors); human conditions (physical/physiological, mental/emotional, experience/exposure); vehicular (tires and wheels, steering, power train and exhaust, driver seating and controls, brakes, suspension, communication, body and doors); and environmental (highway, ambience). A causal factor rating system is used to assign data obtained which will be used later in identifying overall causal factors for individual accidents. The IRPS causal hierarchy has been judged as a reasonably sound classification and assessment system, but improvements are needed: to minimize difficulty of choosing categories, to provide an appropriate level of breakdown for large, frequently cited categories; to maximize tailoring of categories and definitions to prevention/countermeasure areas; to assign technicians to making assessments only at higher (less detailed)

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- criteria
- in the Appen-
life (TL), Permanent
---------- Period (TP) and Incidence (IN).
y scales have proved inaccurate in assessing injury
. any improvements in relationships between AIS units would require further examination and quantitation of each criterion.

by John D. States
University of Rochester School of Medicine, Dept. of Orthopaedics
Publ: HS-801 979 (ZQ-5731-V-1), Motor Vehicle Collision Investigation Symposium Vol. 1: Proceedings, 1976 p416-31 1976; 18refs
Availability: In HS-801 979

HS-019 530

THE FIRST DIGITAL AUTOMOTIVE DIAGNOSTIC SYSTEM - AUTOSENSE

The first digital automotive diagnostic system called Autosense, can run individual tests and thus be used by mechanics as a tool, or automatically step the mechanic through a sequence of tests to diagnose a specific vehicle problem, totally check a vehicle, or its individual systems. The

levels as ascertained experimentally; and to further study the validity and reliability of the various clinical assessment methodologies (such as numerical probability estimates).

by John R. Treat; David Shinar
Indiana Univ., Inst. for Res. in Public Safety
Publ: Investigation Symposium Vol. 1: Proceedings, 1976 p458-80
1976; 6refs
Availability: In HS-801 979

HS-019 532

THE ACCIDENT GENERATION PROCESS

An approach to the study of accident causation and the philosophy behind it is presented in which causes of accidents are given in terms of a description of events and conditions leading up to the crash. A determination must then be made as to which sets of events and conditions to describe. An accident is described not as a single event, but as a process which cannot be explained by a single factor. There are causal links involved, each preceded by another and each preceding link has less relevance to the individual accident. When describing the generation of individual accidents, the events immediately preceding the crash should be concentrated on. A format with which to describe pre-crash events and conditions should be detailed and descriptive; this is the most flexible type. This type of format, however, allows the study and understanding of only a few accidents. The necessity to study hundreds or thousands of accidents implies the need to use statistics and the computer, and it is, therefore, necessary to reformulate the information in the sentences and diagrams into countable, categorical items. The approach outlined divides the accident generation process into its component parts, and provides an exhaustive list of mutually exclusive items for each of these parts. The resultant series of checklists is causal structure. One causal structure is coded for each vehicle in an accident, allowing statistical analysis with either the driver/vehicle unit or the accident as the statistical unit. The most important parts of the causal structure are: the critical event, which is the focal point of a causal analysis and is the last behavior of a DVU (driver/vehicle unit) before the crash became inevitable, short of skilled maneuvers; the target, which is that element of the causal structure which signifies an accident has occurred, the identification of the thing struck, a rollover, or a road departure, whichever occurred first; the accident configuration, which is a group of causal elements which describes the subject vehicle's path and the location of the target and the target's path in relation to the subject's path; the critical reason, which denotes the condition allowing or eliciting the critical event; the critical source, coded whenever the critical reason is external influence, secondary, or an information failure, is the agent acting upon the subject vehicle; and culpability, which is a concept based on the view that, in order for traffic to flow with reasonable fluidity and safety, drivers must be able to rely upon their expectations, i.e. vehicles must stay to the right, stop at stop signs, etc. A situation is said to be abnormal, if the expectations of a hypothetical, normal driver would be violated, and the first DVU to create an abnormal situation is said to be culpable. The three main points of the paper are, in summary: accident causation, in terms of the progress made, is a new area, but it appears to be susceptible to systematic analysis; the causal structure can and has been applied to both detailed accident data and police reports; and there is a definite value in having a logical, structured framework to describe the accident generation process. Appendices contain detailed descriptions and examples of the parts of causal structure and an example of an actual coding form.

by Kenneth Perchonok
Calspan Corp.
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1976
Availability: In HS-801 979

HS-019 533

A MOTOR VEHICLE ACCIDENT CAUSAL SYSTEM: THE HUMAN ELEMENT

A scheme for accident investigation research studies is presented from a human factors standpoint. The system is based upon an analysis of the cause and effect relationships that form the last major link in the chain of human factors and events that lead to an accident. An "effect" is the primary failure, nonperformance or behavior which led to the collision; a "cause" is the factor or event that is the immediate reason for the failure, nonperformance, or behavior. An example of a human causal chain is provided, along with similar chains for each major highway system element involved in a hypothetical crash. Human causes and human effects are concentrated on in the system described. The effect of the human situation in driving is dependent upon how well the driver processes pertinent information signaling him that he is on a collision course and how he responds to that information. Human information processing is described as four distinct, yet interrelated processes: perception, the operator simply does not receive the danger signal or stimulus; comprehension, the signal is within the sensing range of the operator, but for some reason he does not process the information as a danger signal; decision, a processing failure occurs when the operator receives the signal, properly processes it, but makes an incorrect decision in his attempt to compensate for the danger; and action, this failure occurs at a point after the signal is received, comprehended, and a reasonable or proper decision is made. The operator merely physically performs incorrectly. Reasons for the information processing failures vary and many reasons involve vehicle, highway, and ambient conditions. Human reasons include: physical or physiological failures such as stroke, heart attack, or falling asleep; conditions or states, physical or mental, which affect processing behavior; experience or exposure, if prior experience with a signal never indicated danger before, the driver may not comprehend it appropriately; conflicting behaviors or preoccupation, involves behaviors which interfere with the perception or comprehension of the stimuli, such as talking to a passenger or preoccupation with a radio broadcast; and risk taking behavior involving the intentional risk taking actions by a driver which ultimately affect his ability to process and compensate for danger signals. This human causal system can be applied to an accident causation system by determining the primary or principal causes - a factor or combination of nonperformances acting together which were necessary to the occurrence of the accident, by determining the severity increasing factor - a factor or combination of nonperformances which increased the impact speed of the accident, and by determining the relevant conditions - the existing conditions or behavioral states which induced or produced human processing failures. The benefits to be derived from the system are improvement and better definition of the state-of-the-art of accident causation, and the countermeasure implications to be derived from the results of using the system. This accident causal system should provide

future of causal and related studies concludes the paper.

by Kenneth Perchonok
Calspan Corp.
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Availability: In HS-801 979

HS-019 535

A CAUSAL MODEL FOR SINGLE VEHICLE ACCIDENTS

A causal model is described as a collection of integrated components, consisting of a description of the activities and events in an accident sequence; the specification of appropriate categories of causation; and a causal factor taxonomy. The accident sequence occurs when one or more failures in the Function Event sequence (information processing, driver action, vehicle action) takes place. Illustrations show a conceptual model of the driving process/accident sequence and initial driver/vehicle actions in an accident sequence. Categories of causation considered are accident occurrence and injury/damage production. The primary causes of the occurrence of an accident are the presentation of the tasks themselves; a crash will generally be the result if the task is difficult enough and/or if the event failure is substantial. Human predisposition, in which the driver becomes incapable of executing the function event sequence, and environmental predisposition, in which, after the vehicle has left the roadway, a crash is inevitable due to lack of time or space to execute the function event sequence, are two circumstances in which failures are likely to occur in all activities in the event sequence. Causal factor taxonomy is the actual classification scheme for the individual causal factors. The two categories of causal factors, those precipitating or contributing to accident causation and those influencing the severity of damage or injury resulting from the crash, are depicted in an illustration in which all causal factors are classified according to their relevance to the cause or severity of the accident. Within each of the classifications, human, vehicle, and environmental, causal factors are subset into several general categories, the environmental causal factors list being the largest since these were identified by environmental features more easily described. Accident causation classifications include: task/situation display, in which precipitating causal factors require a positive response by the driver; event sequence failure, human and environmental predisposing factors are included; crash configuration, in which causal factors are classified according to the configuration of the crash occurrence which results from the event sequence as well as the location of the crash failure; and injury/damage severity causation, the causal factors influencing the severity only of a crash occurrence are classified as to whether this factor increased or decreased the damage/injury extent. The use of a causal model is recommended since it can aid in the identification and evaluation of potential counter-

...ability
...the study of factors in-
...ws culpability rates as a
...rease in culpability for in-
...neither these findings are primarily
...effects or to driver effects is unknown.
...these data have shown that the youngest
...rivers (highest culpability rates) were over-
...n older cars; nonetheless, after statistically controlling driver age, increased culpability with increased vehicle age was still observed. Table one reflects three types of multivehicle accidents with the emphasis on rear-end accidents. In the loosely coupled type, the lead vehicle decelerated, and the following vehicle was slow in responding; the tightly coupled type reflects a tailgating situation in which the deceleration of the lead vehicle was equivalent to imposing upon the following vehicle. The uncoupled types accounted for 17% of all urban multivehicle accidents and 66% of all urban rear end accidents. Figure three contains only culpable drivers and represents the proportion of drivers initiating accidents who did so due to information failures. The results show a decrease in information failures from daytime to nighttime accidents, and from lighted to unlighted roads for nighttime accidents. Figure four reflects only elements of the causal structure without reference to the accident context. It includes only accidents where the culpable vehicle struck another vehicle due to an information failure. The greatest susceptibility to information failures leading to accidents occurred for targets on a parallel path to the left rear--the classical blind spot. This suggests that either improvements in the rear viewing system are needed or that drivers fail to utilize existing systems. General comments on the use of causal analysis are made: it can be a useful tool for comparing the effects of context variables on the accidents via statistical analysis; its results may be useful for driver education purposes; and it can be used to identify safety problems,

measures which may reduce task presentations, accident causation mechanisms, and injury/damage severity.

by Charles N. Kurucz; Bertan W. Morrow
University of Miami
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Availability: In HS-801 979

HS-019 536

ACCIDENT PREVENTION AND AVOIDANCE ASSESSMENT METHODOLOGIES

Two methodologies of assessing measures that are supposed to help avoid and prevent accidents are the radar/anti-lock assessment and the emergency traffic conflict taxonomy development and avoidance assessment. The former involves assessment of radar-warning, radar-actuated, and anti-lock braking systems in ten hypothetical system models applied to 215 actual accident cases. The most beneficial model proved to be the most complex (noncooperative warning with actuation and four-wheel anti-lock) which would have prevented from 18.1% to 41.9% of the accidents. The second methodology involves development of situation and maneuver taxonomies, based on 372 in-depth case reports involving 613 drivers. For each driver, probability of avoidance was independently evaluated by at least two people for each of 32 different maneuvers involving path, speed, and intent components. The only relevant situation taxonomy proved to be "driver versus another vehicle," which represented 80% of the drivers studied. As an example of results, the most common situation was that of "in intersection, vehicle crossing in front," for which maneuver 2.1, "straight then right, continue past, braking," was the most effective. Overall conclusions drawn from the two assessment methodologies are that in 21% of the emergency traffic conflict situations, perception didn't occur in time to permit any avoidance maneuver, and in 47% avoidance was either certain or probable; of those who attempted to avoid the accidents, 45% locked the wheels of their vehicle; and the most successful maneuver for all situations was steering right and braking. Both approaches are conceptually straightforward but manually laborious. NHTSA accident data files are excellent sources of data.

by John R. Treat; Nicholas S. Tumbas; Ronald W. Drahos
Institute for Res. in Public Safety
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Availability: In HS-801 979

HS-019 537

LEGAL ASPECTS OF COLLISION INVESTIGATION

The most common legal complication of collision investigation is the intrusion of private litigation into the investigative process, e.g., refusal of a driver to make a statement, or withholding of a vehicle from team examination. Under the present state of common law and Federal statute law concerning information disclosure, accident investigation teams have no ability to resist a litigant's inquiry, thus risking disclosures that would constitute an invasion of privacy. It is recommended that the team keep a low profile and that it process its files in such a way as to make identification and retrieval of recommendation is that the team not advise the interviewer of litigation unless directly questioned. Application of the Privacy Act to NHTSA accident investigation records is not clear; NHTSA seeks an amendment to provide a privilege for such files.

by John G. Womack
National Hwy. Traffic Safety Administration, Washington, D.C. 20590
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Availability: In HS-801 979

HS-019 538

TRAFFIC SAFETY RESEARCH IN CANADA

Countermeasures Development of the Canadian Road and Motor Vehicle Traffic Safety Branch, Ministry of Transport, is mandated to identify cost-effective solutions to road safety problems that will bring about reductions in road casualties. Its annual budget is about $1 million, and it conducts about 20 projects at any given time. An organization chart is presented. Major research areas are restraint systems (seat belt) effectiveness, including possible effect of legislation for mandatory use, reduction of injury severity, and current usage of and attitudes toward seat-belt usage; and alcohol-related studies. Other research areas include collision avoidance, data collection, treatment priorities for roadside hazards, roadway lighting, road surface friction, enforcement studies, evaluation via TRIAD (Traffic Accident Information Data System), and human engineering studies at the Defense and Civil Institute for Environmental Medicine. Some research is also conducted at the provincial level of government. A goal for future research is overcoming deficiencies in countermeasure performance and cost data.

by James G. White
Ministry of Transport, Canada
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Availability: In HS-801 979

HS-019 539

ACCIDENT INVESTIGATION AS A BASIS FOR ROAD SAFETY RESEARCH

Road safety research in Great Britain is under the jurisdiction of the Department of the Environment's Minister for Transport, on a customer/contractor scheme in which the customers are policy directorates in that Department and the contractor is the Department's own Transport and Road Research Laboratory. The Laboratory's Safety Department has three divisions: Accident Investigation, Vehicle Safety, and Road User Characteristics. Accident investigations are carried out on three complementary levels: national data recording systems, intermediate level (mainly highway safety), and in-depth accident and injury investigations, including both on-the-spot work and injury causation studies. Priorities include improved accident investigation techniques, improved road en-

Availability: Corporate author

HS-019 542

SAFETY AND LOCATIONAL CRITERIA FOR BICYCLE FACILITIES. FINAL REPORT

Documentation is presented on all research on bicycle facility planning and design done by the Federal Highway Administration in 1973 (companion volumes present user-oriented versions). Subjects covered include: cyclist perceptions of existing facilities; bicycle accidents; safety and operating parameters on linear facilities, including speeds and mixing, operating space, effects on driver and cyclist behavior, sight distance, braking, turn radius, user satisfaction, bidirectional travel, usage of highway shoulders, and physical barrier and stripe separation feasibility. Also considered are safety of bikeway intersection treatments; bike lane intersection operations studies; bicycle turn-lane installation; evaluation of bikeway conflict reduction; traffic control at intersections; intersection simulation models; and locational planning, including grades and air quality research and estimation of bicycle activity and survey research techniques. Bike lanes are perceived as significantly beneficial. They have positive impact on traffic flow characteristics, and are significantly more effective in reducing vehicle-bike accidents than previously believed. Bicycles and motor vehicles should not be mixed in a single traffic stream unless there are factors making them compatible such as constrained vehicle speed. Bidirectional facilities are strongly discouraged. Poor routing leads to nonuse of a bike route. There is no one typical bicyclist. Six levels of bicycle service can be defined, as well as specific criteria for width of facilities. Equations for sight and stopping distance have been prepared. It would be appropriate to consider warrants for traffic control. A set of planning criteria has been developed and needs wide dissemination.

by Daniel T. Smith, Jr.
De Leuw, Cather and Co., P.O. Box 7991, San Francisco, Calif. 94120; Univ. of California, Davis; Bicycle Res. Associates, Davis, Calif.
Contract FH-11-8134
Rept. No. FHWA-RD-75-112 ; 1976; 253p 76refs
Availability: NTIS

HS-019 543

A STUDY ON DRIVING RECORDS, LICENSING REQUIREMENTS AND INSURABILITY OF PHYSICALLY IMPAIRED DRIVERS. FINAL REPORT

This compendium of reports covers licensing, retraining, accident involvement, driver weaknesses and shortcomings, and insurance considerations for physically impaired drivers. Study shows that their driving ability is above average, accident involvement is below average, and that they are excellent insurance risks. Recommendations suggest wider dissemination of existing knowledge concerning capabilities of impaired drivers, and that physical impairment should not be a limita-

en K. Miller
agen of America, Inc.
S-801 979 (ZQ-5731-V-1), Motor Vehicle Collision
ation Symposium Vol. 1: Proceedings, 1976 p592-8
efs
ility: In HS-801 979

HS-019 541

AUTOMOTIVE FUEL ECONOMY (SELECTED SAE PAPERS 1965-1975)

Twenty-two articles are presented in the following subject areas: fuel economy test procedure (new SAE measurement procedures); vehicle usage factors affecting fuel economy (estimation of customer fuel economy, vehicle operation versus fuel economy, passenger cars in nonurban driving, passenger cars and trip length); vehicle design factors affecting fuel economy (trends and influences, modern superhighways, improvements, technology, 1975 Union 76 fuel economy tests, mileage improvement techniques); fuel and lubricant effects on fuel economy (gasoline factors, European views of fuel economy, cold-start driveability in recent models, lubricant viscosity); and analysis of fuel economy (fundamental parameters of economy and acceleration, general-purpose performance and

Availability: NTIS

HS-019 544

EMERGENCY VEHICLE WARNING DEVICES. INTERIM REVIEW OF THE STATE-OF-THE-ART RELATIVE TO PERFORMANCE STANDARDS. LAW ENFORCEMENT STANDARDS PROGRAM

The effectiveness of an emergency vehicle warning system is determined by how well it alerts other drivers and pedestrians to the presence or approach of an emergency vehicle, and enables a path to be cleared for the emergency vehicle through traffic. Effectiveness is influenced by such parameters as type of emergency vehicle, types of warning devices on the vehicle, weather conditions, time of day, road and traffic conditions, and destination of the vehicle. A warning device must overcome distractions such as flashing neon signs, car radios, air conditioning systems. At present no reliable agreed-upon means exist for determining how effectively a device or combination of devices has fulfilled the required functions. Tests are being performed to determine parameters that influence sound output and signal characteristics. Several types of sirens on both stationary and moving vehicles were tested with microphones used to record the data. Mechanical and electronic sirens were tested, with results showing that when mounted on stationary vehicles, the signals were strongest in the front, less strong on the side, and weakest to the rear. Thus the sound might not be discernible to a motorist above ambient noise after the siren had passed. The signal output of the mechanical siren was found to be more complex in intensity distribution patterns as it is almost as loud after it passes when its warning function would have been completed, thereby risking unnecessary disruption of traffic flow behind the vehicles. In tests to be performed on emergency flashing lights, the evaluation of each lighting unit will include a determination of the chromaticity coordinates, intensity (candlepower) distribution, and effective intensity. Units employing movable lenses or reflectors for flashing effects will be evaluated as well as the outputs of power supplies for incandescent and capacitor discharge. The complete listing of emergency vehicle warning lights is planned along with visits to warning light manufacturers. The information thus derived from all these sources will be used in drafting interim standards. To determine effectiveness in sirens, a systematic parametric study of auditory signals must be conducted until a body of data has been established to permit evaluation of a siren directly from physical measurements of sound output and also the selection of an optimum siren for any specified background. This collection could be handled with simulation techniques superimposing various siren sounds on typical traffic noise. As yet no such experiments have been performed. Effective warning lights could be determined through simulation experiments that measure complex reaction time, though data on the effectiveness of flashing lights are difficult to come by. Plans are underway to search the related literature and begin a pilot program into the feasibility of using simulation techniques. The effectiveness of a total signaling system

by E. T. Pierce; K. L. Kelly; M. A. McPherson; G. L. Howett; R. L. Booker
National Bureau of Standards, Washington, D.C. 20234
Contract LEAA-J-IAA-009-2
Rept. No. NBS-10-478; LEAA-LESP-0501.00; PB-211 938 ; 1972; 83p 48refs
Availability: NTIS, $3.00

HS-019 545

MULTIVARIATE ANALYSIS OF TRAFFIC FACTORS RELATED TO FUEL CONSUMPTION IN URBAN DRIVING

Detailed speed, acceleration, and fuel consumption records of an experiment involving 383 km of driving in the Detroit metropolitan area were analyzed by multivariate statistical techniques (correlation analysis, principal component analysis, factor analysis, and multiple-regression analysis) in order to identify pertinent measures of traffic-related speed-time characteristics that influence fuel consumption in urban driving. Data reduction was to portions of data representing travel of two miles; 17 variables were selected for the analysis. Average trip time per unit distance proved to be the single most important factor in explaining the variability of fuel consumption; other important factors were the work per unit distance to accelerate the vehicle and the fraction of distance covered with a deceleration greater than 0.15 miles per second squared, which is probably related to the fraction of distance traveled while coasting or braking. The results can be explained in terms of the physical properties of the engine-vehicle system and the interrelationships among the traffic-related variables. For urban trips over a large area, reduction of average trip time over the system by traffic engineering means would reduce overall fuel consumption if it did not at the same time encourage additional travel.

by Leonard Evans; Robert Herman; Tenny Lam
Publ: Transportation Science v10 n2 p205-15 (May 1976)
1976; 13refs
Availability: See publication

HS-019 546

DRIVER RESPONSE TO AN AIRPORT RADIO INFORMATION SYSTEM

A restricted-range radio system licensed by the FCC on a trial basis for use at Los Angeles International Airport to give approaching drivers information on parking opportunities and other traffic and driving information was evaluated for acceptance and effectiveness by surveying motorists during Nov and Dec 1973. Short-form questionnaires were used on a sample size giving a 95% confidence level with a 3% error. It was found that especially the inexperienced private auto motorist entering the airport found the Airport Information System useful and would recommend it to others; that the preferred information was on traffic conditions, parking closures, and airport terminal locations (with priorities varying according to the time

when inexperienced drivers predominate.

by Seymour Lampert; Frank T. Carroll
Publ: Traffic Engineering v46 n10 p17-21 (Oct 1976)
1976; 3refs
Availability: See publication

HS-019 547

FUEL CONSUMPTION, EMISSIONS AND POWER CHARACTERISTICS OF THE 1975 CHEVROLET 350-CID 0CUBIC INCH DISPLACEMENT0 2V AUTOMOTIVE ENGINE--EXPERIMENTAL DATA. INTERIM REPORT

Data gathered in dynamometer testing of the 1975 Chevrolet, 350 cubic-inch displacement, 2-bbl engine are graphed and charted, and include the following information: brake horsepower, torque, and brake specific fuel consumption at wide-open throttle for various engine speeds

ille Energy
74003

-76-36; BERC/OP-76/19; 1976; 40p

HS-019 548

EVALUATION OF THE NEW ZEALAND COMPULSORY SEAT BELT LEGISLATION

Legislation in New Zealand requiring drivers and front-seat passengers of light vehicles first registered after 1 Jan 1965 to wear seat belts as of 1 Jun 1972 has resulted in the following statistical changes: only a 3% increase in driver/front-seat passenger fatalities compared with a 40% rise for all other road users; a significant reduction in fatal and serious casualties for drivers of post-1965 vehicles; and an 11% reduction in accident involvement for those drivers, though there has been a 20% increase in vehicle registrations. Both ticketing and conviction for breaking seat-belt laws have risen, though not at the same rate. The nation's seat-belt legislation is presented in an appendix.

by J. B. Toomath; C. G. Laurenson
Ministry of Transport, Rd. Transport Div., Traffic Res. Section, Private Bag, Wellington, New Zealand
Rept. No. TRR-17 ; 1976; 37p
Availability: Corporate author

testing secondary vehicle safety and equivalent measurements applicable to dummies concentrated on the following working approaches: protection of restrained car occupants, protection of nonrestrained car occupants, and a review of the pedestrian problem. The international group presenting the criteria felt that although biomechanics of impact is as yet a young science, the injury tolerance levels of occupants is a good basis for making standards. The Italian delegation, however, disagreed with this approach. Values are given for the following injuries: for nonsymmetrical frontal impact, head (including brain, skull, face, facial), neck, clavicle, thorax, spine, abdomen, knee-femur and hip, and lower leg and foot; for lateral impact, head (including brain, skull, face), neck, clavicle, thorax, hip and pelvis, abdomen, and femur. Areas requiring further research before standards can be proposed are human tolerance for head injury and for side impacts generally, methodology of measurements, and improvements of dummies, especially their dynamic behavior. Protection for unrestrained occupants remains a valid consideration in spite of mandatory belt use. Mathematical modelling techniques are encouraged for study of pedestrian injury mechanisms. Pedestrian injuries are more severe for adults although more common for children and the elderly; head injuries are the most serious in terms of severity and frequency.

European Experimental Vehicles Committee
1976; 66p 23refs
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 550

DEVELOPMENT OF LIGHTWEIGHT CRASHWORTHY VEHICLE STRUCTURES

Over the past four years Minicars, Inc. has pioneered the development and application of lightweight but crashworthy vehicle structures. Up to now, unibody construction has been the latest development in the evolution of efficient, economical, lightweight structures for road load conditions. The automobile industry must now satisfy current and proposed safety requirements as well as standard road load conditions. Each condition requires different techniques: standard linear elastic design for road loads; plastic deformation over large deflections for energy absorption capability. In all structural design three primary interdependent considerations must be balanced: strength and flexibility, economy in production, and weight. To reduce vehicle weight, less material or lighter materials must be used. Lighter materials of the same strength are more costly. The least costly method is to use steel of reduced gage (less material). A crashworthy vehicle structure is defined as one which produces both survivable space and survivable accelerations for the occupant under prescribed crash conditions, a balance of crash forces and crush distances. In present vehicles, frame collapse is the principal energy absorption mechanism for frontal impacts. (Tables are included of basic crash mechanics.) Outstanding results have been obtained in energy-absorbing capability by using light gage foam-filled sheet metal sections, which offer additional

gy absorption efficiency due to reduced post-elastic load fall-off, increased elastic buckling load due to the stabilizing effect of the foam, and more predictable and controllable crash behavior, which is a great benefit to restraints design. The practicality of these structures for production vehicles has been thoroughly investigated during the RSV program. There are six areas of concern associated with foam-filled vehicle structures, all capable of solution with improved production techniques: the fabrication of closed sheet metal boxes, which creates problems of accessibility of joints to allow for spot-welding; production foaming of thin gage sections; production foaming techniques, due to the necessity for specialized foaming heads and the rise-time of the foam; and the durability and flammability of the polyurethane foam, both of which need long range in-use testing under extreme conditions. Finally, the disposability of the highly stable foam must be demonstrated; techniques of extracting the foam from steel must be developed as well as those of disposal or preferably recycling of the polyurethane. The results of the RSV program studies indicate that lightweight crashworthy vehicle studies are a viable option of the 1985 time frame.

by Richard B. Tanner
Minicars, Inc., Engineering Staff
1976; 12p
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 551

DEVELOPMENT OF A PASSIVE SEAT BELT RESTRAINT SYSTEM

A passive seat belt which is particularly suitable for delivery van drivers consists of a single diagonal seat belt attached to the door along with a knee restraint provided in front of the occupant. Specific features include an inertia reel, a reel control circuit with switches in the door and in the seat, adjustable shoulder anchorage, inboard mounting, a parking hook to facilitate getting in and out of the vehicle, and a knee restraint rigidly mounted across the passenger compartment and designed to collapse at a load lower than that which would cause damage to the femur. Trial installations are being made in six post office vans. The single diagonal and knee restraint system is the optimum in cost effectiveness for a passive restraint system.

by Roger A. Ashworth
Kangol Magnet Ltd., United Kingdom
1976; 9p
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

A series of free fall head impact tests was carried out on unembalmed cadavers, helmeted and nonhelmeted, a Hybrid 2 anthropomorphic dummy head, and a light alloy metallic headform. In all cases, the head strikes a flat rigid surface. The height of the fall and the helmet differ; the desired point of impact of the head is invariably the same and would correspond on the human head to the lower part of the parietal bone near the temporal bone. The impact brought about can be compared to a lateral impact where data concerning human tolerance are rare. It is generally assumed that tolerance to the lateral impact of the head is lower than tolerance to impact on the frontal bone, and this has been verified by the level of effort needed to obtain this fracture. The helmets used are available on the French market and were selected because of their wide availability and their relatively thick shock-absorbing material in the impact zone. The dropping heights used were 1.83 meters in the first test series and 2.50 meters in the second. Damage to the brains of the human subjects was studied microscopically and macroscopically through detection of the mixture of formol water and india ink injected into the circulatory system prior to impacting. It was concluded that, with the helmets tested, serious brain lesions were revealed in only one out of the nine cases. Without a helmet, injuries were found in one subject; rupture of the corpus collosum and important hemorrhages in the internal faces of the temporal structures and in the brain stem. Such injuries are considered as fatal. The other test without a helmet was invalidated due to the failure of the injection to reach deep brain structures. Tests with the dummy head resulted in lower accelerations than during comparable tests with human subjects. The results do not reveal a lower tolerance as measured on the dummy, but the fact that the test imposed on the dummy head was less severe. Changing from the Hybrid 2 dummy head to the metal head resulted in an increase in the acceleration levels measured. From the tests on human subjects, it was concluded that certain current helmets protect against skull fracture and cerebral lesions in impacts on the lateral head face up to at least a 2.5 meter dropping height; that SI (severity index) and HIC (head injury criteria) values going over 2100 can be supported without indication of even notable microscopic lesions; that the test conditions are applicable in any situation when the impact duration is over approximately 12 milliseconds which covers the impact conditions most frequently observed in real crash conditions. The tests with Hybrid 2 dummies lead to the proposal of a HIC of 1500 as a protection criterion in case of a frontal or lateral head impact. Photographs are included which show injuries to brain sections of human test subjects, and tabulated materials present test results.

by A. Fayon; C. Tarriere; G. Walfisch; C. Got; A. Patel
Laboratoire de Physiologie et de Biomecanique de l'Assoc. Peugeot-Renault, France; Institut de Recherches Orthopediques de l'Hopital Raymond Poincare, France
1976; 20p 7refs
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

those from various sports and other activities shows some similarities, e.g. upper spinal fractures in motorboaters and in parachutists using explosively-powered ejection devices, and rib-cage fractures of motorboat operators following a chest–back line, as in frontal impacts. Factors influencing differing responses include age, gender, race, corporeal composition, and genetic constitution. Differences in methodology also affect results, e.g. thoracic cage studies by both the rib deflection method and by deceleration measurement. Although biomechanics is as yet a young science, safety measures such as seat belts and vehicle roll bars which are based on common sense and from whatever reliable data do exist are encouraged.

by Antonio Dal Monte
University of Rome, Chair of Sports Medicine, Rome, Italy
1976; 10p
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

...an impacts was conducted
...otential of the front end of the
...vehicle) compared with the per-
...ative production (baseline) vehicles;
...-size vehicle) and a 1974 Vega (compact
...h HYGE crash simulator was used as
...erator to propel the vehicles mounted on the sled
...ding 50th percentile adult and six-year-old child dum-
...mies positioned to represent the walking mode. Performance was evaluated over a 20-25 mph speed range and preliminary results indicate that acceleration levels of the head, chest, pelvis, and knee for both the adult and child dummies are significantly reduced (by about 50-75% respectively) in impacts with the RSV, and that the softened RSV bumper would reduce vehicle contact-induced leg injury. It appears that the injury attenuation performance of the RSV might increase the permissible impact velocity for a given level of injury by as much as five to ten mph. Photographs are presented of the test setup and impact sequences and graphs illustrate various test results.

by H. B. Pritz
Battelle Columbus Labs., Columbus, Ohio
1976; 15p
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

ing the accident file corrections used in Phase One to be more representative of larger files which, in turn, were corrected to represent the total number of annual real-world U.S. accident and fatalities. From these files, detailed examination identified the velocities and modes contributing most of the societal costs of accidents. A description of cumulative societal loss for various selected damage area impact modes was obtained by adjusting the Multi-Disciplinary Accident Investigation (MDAI) file to describe unrestrained occupant accidents in vehicle-to-vehicle and fixed-object impacts in six selected modes. Resulting data permitted proper weighting of costs among various modes in conjunction with CAL II Abbreviated Injury Scale distributions in each mode, within one accident analysis program. Preliminary relationships between unrestrained occupant injury measures were related to societal cost. Velocity relationships for selected damage area impact force combinations were identified, and side impact test modes were selected. The predominate impact configuration by societal loss and frequency is the nine o'clock and three o'clock impact angle sector. Alternative test philosophies were considered to assure optimum test selection. The results of the analysis have identified more specifically the crashworthiness and injury reduction goals of the Minicars RSV program, leading to recommended test matrices for the Phase Four efforts. Nineteen test modes are diagrammed in the categories of frontal vehicle-to-vehicle, side vehicle-to-vehicle, rear vehicle-to-vehicle, fixed object test, and rollover.

by Keith Friedman
Minicars, Inc.
1976; 29p
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 556

INFLUENCE OF INTRUSION IN SIDE IMPACT

Since early 1970, the Impact Research Laboratory of the French National Highway Safety Organization has carried out an investigation of 743 highway accidents in the Lyon and Marseille areas. The 66 vehicles studied for this report had to meet three accident criteria: the main forces during impact were transversal rather than longitudinal, the impacted area was the lateral area of the car, and they were car-to-car accidents. In addition, car-to-car experimental crash tests were carried out, one half on standard model cars and the other half on a test device with a steel shield. The results of the accident investigation indicated that the frequency of side impact accidents is high (20% of car accidents) and more serious than other accidents. The severity of injuries increased with intrusion, especially for occupants on the impacted side. Side impact involves injury to the pelvis and vertebral column, the lower limbs being affected much less frequently. The testing results showed that nonintrusion due to the stiffened side steel plate decreases the risk of severe injuries at a speed of up to 50 kph, decreases the accelerations and forces exerted on struck car dummies and does not increase appreciably the

Chocs et de Biomecanique, 109 Ave. S. Allende, 69500 Bron, France
1976; 21p 12refs
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 557

COMPARED INFLUENCES OF DELTA V, MEAN GAMMA AND INTRUSION UPON THE OVERALL SEVERITY OF INJURIES IN FRONTAL IMPACTS

It is generally accepted, and has been proved by experiments, that the severity of occupant injury in vehicle collisions depends on the delta V and the law of deceleration (gamma), not to intrusion on survival space. The aim of the present study is to confirm the above relationship, corroborating it with accident investigation analysis involving unbelted occupants. The method used in this study is a simple application of data processing techniques and calculations called orthogonalization, which is designed to enable the researchers to estimate independently the effects of delta V, mean gamma and intrusion on the severity of injuries to occupants resulting from impact as well as the effects of interaction of the above factors. The results indicate that the first two factors have the greatest effect on severity of injury and that the third has only a small effect. A study with belted occupants would give different results.

by F. Hartemann; C. Henry; C. Tarriere
Laboratoire de Physiologie et de Biomecanique de l'Assoc. Peugeot-Renault, France
1976; 13p 2refs
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 558

GERMAN AUTOMOTIVE INDUSTRY. STATUS REPORT TO THE 6TH ESV CONFERENCE

Automobile research and design in Germany during 1975-1976 has included accident research, biomechanics, occupant protection, body design, pedestrian protection and related vehicle design, handling dynamics, and a study on the harmonization of technical regulations. Accident research has featured more detailed data acquisition by both police and insurance companies, and an emphasis on pedestrians, motorcycle drivers, and cyclists, who together represent 50% of the country's accident casualties. The lack of a satisfactory and internationally acceptable terminology is a problem in accident research. A multidisciplinary research team in biomechanics has been established to work on injury and protection criteria. As for occupant protection, there has been standardization of press buttons of automatic three-point belts, and development of specifications for protection of infants and small children. tion of technical regulations concerns those issued by the Economic Commission for Europe (ECE) and the European Communities (EC) emphasizing the need to use benefit-cost analyses and to bring U.S. and ECE specifications closer together.

by Gunther Brenken
Verband der Automobilindustrie e.V., Frankfurt/Main, Federal Republic of Germany
1976; 21p
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 559

AN ESTIMATION OF THE COMPLEXITY OF THE CONTROL LOOP ENVIRONMENT--DRIVER--VEHICLE CONSEQUENCES FOR RESEARCH AND LEGISLATION

That the objective measurement and description of vehicle dynamics is still a difficult, complex task is demonstrated by a study of the control loop or relationships between environment, driver, and vehicle. Information starts from the environment, passes to the driver and from the driver to the vehicle. By far the most likely area of bad information processing is the driver rather than the vehicle. Quality of information processing depends on filtering out of indifferent and disturbing data by the driver and on predictability of behavior of the vehicle. Test methodology for traffic safety should include determination of which part of the control loop is in operation. Three possibilities are open loop with objective judgment (driver influence is excluded), closed loop with objective judgment (some driver input allowed), and closed loop with subjective judgment (unrestrained, e.g. actual road tests). Most research is based on the third method; the relation between objective test results and traffic safety is unknown, and the limits of current technology have almost been reached. Given the complexity and ambiguity of the control loop, further research should concern driver behavior prior to accidents and the frequency of typical driving situations prior to the accidents. Legislation should use as its guideline only the state of the art of research rather than look for any finalized criteria.

by Kurt Enke
Passenger Car Devel., Daimler-Benz A.G., Federal Republic of Germany
1976; 14p
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

potentially associated with loss-of-control accidents. About 100 subjects, chosen to approximate the New York State driving population, drove either a standard or modified Chevelle over a 1.2 mile course which included off-shoulder recovery, wet surface, gravel turn, exit chute and braking, an S-shaped section, both large and small arcs, a surprise obstacle, an avoidance problem and a stop section. The effect of the vehicle modified to increase maneuvering capability was to increase accuracy when driven normally and to be equivalent to the standard vehicle's performance rate if driven more aggressively in terms of speed. Increasing familiarity with the course led to a 20% reduction in trial time. Younger drivers showed an imbalance between skill and aggressiveness; older drivers were more prudent and skillful. Drivers are not prepared to utilize the maximum lateral capability of present vehicles in a transient or steady state context, do not adapt quickly to reduced-friction conditions, to the advantages of coordinated braking and steering, or to methods of recovering from a skid, and are not prepared naturally to select the most effective control element for an emergency situation. Some drivers have long reaction times. Drivers adapted quickly to characteristics of unfamiliar vehicles.

by R. E. Rasmussen
General Motors, Engineering Staff

ice on
2-16 Oct

N LEVELS FOR MINIMUM BRAKING DLING PERFORMANCE

Since 1970 an extensive research program has been in progress within the United States to identify appropriate criterion levels for minimum braking and handling performance of passenger cars. The predominant methodology has been oriented toward skid pad performance measures. When indirect measures of safety performance are used, vehicle design should be evaluated in context with other elements of the driver-highway system that influence braking and handling qualities. Ford conducted a pilot study of braking efficiency to demonstrate how the Federal Highway Administration's "Margin of Safety" concept can be applied to vehicle brake performance as well as pavement friction evaluation. This Margin of Safety refers to the difference between the severity of maneuvers performed by drivers on public roads and the levels of pavement friction available to perform those maneuvers. Ford's study used indirect measures of safety performance, principally the proportion of drivers who exceeded speeds that would allow them to stop in time if a vehicle or pedestrian were standing in the road just beyond a blind turn. The results indicated that tire-pavement traction is the dominant factor in vehicle braking performance on public roads. This finding is consistent with other published evidence that small differences in pavement friction levels produce detectable differences in accident rates. Accident data sensitive enough to detect such effects should

by Lyman M. Forbes
Ford Motor Co.
1976; 11p 13refs
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 562

A STATUS REPORT ON THE CALSPAN/CHRYSLER RSV (RESEARCH SAFETY VEHICLE)

The Calspan/Chrysler RSV (Research Safety Vehicle) program approach is based on derivation of the RSV from a current state-of-the-art production automobile because only incremental design changes between the base vehicle and the RSV need to be investigated to establish the production feasibility of the resulting design. Basic geometrical design, drive system, chassis, and other properties of the base vehicle are reflected in the RSV design. The Simca 1308 was selected as the base vehicle since it represents advanced engineering practice. Extensive active and crash safety tests performed with the base vehicle indicated that nearly all of its active safety characteristics (braking, handling, etc.) met or exceeded RSV requirements. An exception was noted when a front brake system failure condition was simulated and the specified stopping distance was exceeded. RSV development was divided into three categories, styling, crash safety, and vehicle systems; principal effort was expended on crash safety. An attempt was made to carry over to the RSV a maximum number of base vehicle exterior and interior parts, but in view of pedestrian impact requirements, a completely different front facia was necessary. Crash safety activity was divided into categories of bumper, structure, and interior-restraints. A high-density urethane foam skin with crash energy management provided by a low energy absorbing foam was employed to make a bumper which would provide pedestrian protection and minimize vehicle damage during low-speed collisions. Steel was the primary structural component and major changes were made in the front and side structural components. Crush tests preceded the design changes. Vehicle compatibility was extensively investigated throughout the structural development to insure the RSV would not have a severe adverse effect on other heavier and lighter cars. The RSV front seat restraint is a passive torso belt, optionally semipassive lap belt system developed using the Calspan Crash Victim Simulation model and evaluated with the Calspan HYGE sled. The rear seat occupant restraint is a conventional three-point unibelt system, except that force limiting is provided in the upper torso belt. A special energy-absorbing door trim panel was developed to provide energy management during lateral collisions. Incomplete preliminary system integration test results indicate that there is improved structural performance in the RSV after 45 mph barrier impacts, and that all measured parameters nearly meet the injury criteria for vehicle occupants. A diagonal split braking system and a changed power plant are the only two major vehicle systems changes made between the

1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 563

CROSSWIND SENSITIVITY: A STUDY CARRIED OUT THROUGH THE DRIVER-VEHICLE SYSTEM. SEMINAR ON ACCIDENT AVOIDANCE

Sensitivity to crosswind is tested during straight driving and cornering and overtaking maneuvers, with an evaluation of the influence of the most important vehicle dynamic parameters and driver behavior and skills. The driver/vehicle system schematization is a mathematical model in which the driver is engaged only with the steering wheel, both a skilled and unskilled driver are considered, and the vehicle is a rear-drive, medium-size sedan. The test has the vehicle on a 70 mph straight path run with a 20 ft wide lateral wind step of 50 mph. Both the open loop and closed loop tests are provided. The cornering and overtaking maneuvers are tested both with and without the crosswind step. Conclusions are that with the same position of center of pressure and changing the understeering degree, open loop and closed loop tests give the same indications and a correlation may be established between them; that with the same understeering degree and changing the center of pressure position, correlation is poor; that the same thing happens when changing simultaneously the understeering degree and the center of pressure position. The open loop test might be proposed, provided the allowable lateral deviation is reduced; on the other hand, such a reduction might penalize solutions which, in the closed loop test, have an acceptable behavior. Open loop testing should be correlated with real maneuvers and situations in which the driver is always engaged, using mathematical modelling.

Alfa Romeo S.p.A., Milan, Italy
1976; 36p 3refs
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 564

NON-SYMMETRICAL FRONT IMPACT AGAINST BARRIER ANALYSIS OF THE DIFFERENT CAR MODELS AND CONSEQUENCES TO THE OCCUPANTS. SEMINAR ON THE VEHICLE STRUCTURAL PROPERTIES

Alfa Romeo proposes that nonsymmetrical frontal impact tests more accurately reflect real life collisions than do symmetrical tests, as the majority of occupant casualities in frontal impacts occur in nonsymmetrical collisions. To further information on nonsymmetrical collisions, particularly to determine if a nonsymmetrical deformation causes different accelerations between driver and passenger, Alfa Romeo carried out two symmetrical and four nonsymmetrical tests against barriers using two car models differing in weight, architecture and ment motion components that cause the occupants stresses are in practice the same in the symmetrical and nonsymmetrical impacts against barrier: the basic deceleration direction of the compartment is straight and longitudinal. The highest stresses have not been found in the dummy sitting in the more deformed side of the car. Independently from the test type, the severity classification between the car models remains unchanged. The compartment deceleration levels in the nonsymmetrical tests are lower than in the symmetrical tests; therefore, the symmetrical test cannot actually reproduce the great majority of road crashes that involve two vehicles and cause large penetrations. The acceleration levels and injury indices of the restrained occupants in all the tests are correlated to the compartment deceleration levels.

Alfa Romeo S.p.A., Milan, Italy
1976; 28p 5refs
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 565

CAR/VEHICLE SIDE IMPACTS--A STUDY OF ACCIDENT CHARACTERISTICS AND OCCUPANT INJURIES

Analysis of 1,009 car/vehicle accidents having side collisions with lateral direction of impact emphasizes change in collision frequency with increasing severity of occupant injury, mass ratio between frontal and side-impacted vehicles, and standardization of terminology. Side collisions cause 28% of occupant fatalities. Lateral-direction side impacts (57% of side impacts) cause more serious injuries than longitudinal-direction (43%) impacts, although risk of death is about the same for both. In 95% of cases, impact speed was less than 60 km/h; estimates of impact speed in real-life collisions is 50-60 km/h for 90% of all collisions. Light vehicles are overrepresented and heavy vehicles underrepresented in side collisions. Statistics of mass aggressiveness are ambiguous. The majority of intrusions of the occupant compartment in real-life situations were triangular impressions in the area of the front doors, with the B post absorbing a large share of the deformation energy. Characteristic focal points of injury are chest, abdomen, and lower extremities; occupant on the impact side is three to four times more likely to be injured than an occupant on the opposite side. Risk of abdominal injury is greatest when the impact is right-angled. The basic prerequisite for reducing fatal injuries is a reduction in severe skull, thoracic, and abdominal injuries in that order. Side structure of vehicle needs further optimization. Terms which were felt to require definition were the following: car/car side collision as all such accidents in which the case car is subjected to a predominantly lateral collision energy; impact area as the area of main deformation, embracing the area of maximum intrusion in a lateral direction and the entire area of substantial deformation of structural bearing parts; intrusion as a static impression of the occupant compartment between the A and C posts following a collision; direction of impact as the direction of the change in

reflected. Analysis statistics are tabulated and graphics, and photographs illustrate impact areas and intrusion characteristics.

by M. Danner; K. Langwieder
German Assoc. of Third-Party Liability, Accident and Motor Traffic Insurers, Federal Republic of Germany
1976; 41p 16refs
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 566

THE ACCLES BRITAX AUTOMATIC CUSHION RESTRAINT--ITS USE IN DELIVERY VEHICLES

The Automatic Cushion Restraint (ACR), a passive system, consists of a cushion or pad, 70 square inches in area, held in

. ane
ard 12
and 2 inches more than the
accident test using a 190-lb 6-
girl showed both unhurt when
collision with another car at 25-30
ected to have beneficial effects in
. It has further advantages in that it can be locked away from the user when the ignition is off; it can be adjusted to chest and stomach profiles and it is locked in position whenever the footbrake is operated. Users questioned have often said they prefer the ACR to belts. The ACR system can be applied to private cars and is particularly suited to delivery vehicles and the like, where drivers have to enter and leave frequently. The U.K. Transport and Road Research Laboratory is to organize and supervise trials that will include 30 mph impact tests and user studies under service conditions on ACR units fitted to Post Office vans.

by G. Grime; A. Ellis
Accles Britax Ltd., United Kingdom
1976; 17p 2refs
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 567

COMPUTER SIMULATION OF THE PEDESTRIAN IMPACT--DEVELOPMENT OF THE CONTACT MODEL

To study the effects of vehicle front end shape on pedestrian impacts, the Calspan 3-D crash victim simulation program

ment, the option of specifying [illegible] reference; allowing for the effects the effects of shear pins in the dummies on the joint modelling; and changing the joint modelling technique by representing the normal range of joint motion by a fifth-order polynomial power series and the joint stop by a quadratic function. Experimental tests were made to validate the computer simulation of pedestrian impact, using as a fundamental criterion of validity a comparison of the dummy trajectory during the primary impact sequences. There is good general agreement between simulation and tests results, with the soft bumper being fully deflected and the dummy rolling about the leading edge of the hood. The tests were made, however, with an updated version of the program that did not yet include the refinements of the plane segments, and so should not be considered final.

by J. E. Fowler; R. K. Axford; K. R. Butterfield
British Leyland Ltd., Engineering and Product Planning Div., Cowley, Oxford, England
1976; 22p 24refs
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 568

ACCIDENT INVESTIGATIONS OF THE FEDERAL ROAD RESEARCH INSTITUTE

Using official statistics on police-notified accidents where fatalities, injuries, or damage to property occurred, maintained and updated by the Federal government of Germany, evaluations of 1,800 accidents have been made. Statistics gathered have been used in research studies of seat-belt usage, the effects of a 100 km/h speed limit on secondary roads, lateral collisions, and pedestrian accidents. In addition to the evaluation of official accident statistics and the data collections of local accident studies, an attempt has been made to expand the data base for accident research. Research projects on methodological questions of accident statistics are being carried out, such as a pilot study on the subject of registration and analysis of the percentage of hidden accidents occurring in a district with a population of 264,546. Results which emerge show that only about 50% of all road-accident injured persons treated in hospitals are known to the police, that the probability of collection depends on accident severity, type of accident, place of accident, driving experience, involvement in criminal proceedings, and those of insurance compensation. Another project attempts to improve the significance of official statistics by using advanced statistical methods such as cluster analysis, contingency table analysis, Kulback's information analysis, and contrast group analysis. A third statistically and methodically oriented project investigated regional sampling units in highway safety research with the objective of finding out whether it is possible to construct a basic sampling that can be used to carry out investigations irrespective of specific issues. Future efforts will be aimed at coordinating the existing or planned investigations of events and patterns of accidents using the following approaches: combination of current surveys using hospital and police records of accidents with serious injuries; uniform data collection coordinated through the

European Experimental Vehicles Committee and the International Organization for Standardization; and the mean accident data model perhaps using the targets pointed out in the research report of the Highway Safety Research Institute, "A National Accident Sampling System."

by B. Friedel; E. Faerber
Federal Rd. Res. Inst., Federal Republic of Germany
1976; 10p 10refs
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 569

INFLUENCE OF THE SHAPE OF THIN-WALL STRUCTURES AND STRUCTURAL ELEMENTS ON THE DYNAMIC BEHAVIOUR OF THE OVERALL PASSENGER-VEHICLE SYSTEM DURING IMPACTS

During the collision of the vehicle with an obstacle, shock-like impact forces are acting upon the passengers. This shock-like load can be considered as a transient oscillation process. A corresponding analysis, effected at any defined point of the car, reveals that the basic frequency is superimposed by frequency spectra of differing density and direction. The passenger's body also constitutes an oscillatory element, which is represented by muscles and bones on one hand, and the embedded organs and liquids with their respective couplings on the other. Mathematical simulatory models for some subdomains are known from pertinent literature. The frequency spectrum is created during the vehicle deformation phase and transmitted to the passenger through the structural elements, the seat belt anchorage points, or other vehicle parts. From other research sectors it is known that with oscillatory stresses, certain frequency ranges are specially harmful to man. Specifically, for the thorax and abdomen system the critical ranges are generally inferior to ten cycles per second (cps), whereas for the skull and brain more extensive critical frequencies including 3-10, 20-30 and over 100 cps have been reported. It must therefore be assumed that also in the case of shocklike impact forces acting upon the passenger, there are some frequency ranges which have noxious effects on vital functions of the human body. Before closely investigating these ranges, it has to be found out whether it is possible at all to influence frequency ranges by corresponding design of the overall structures and of the structural element. Therefore, an analysis of typical realistic thin-wall structures to be used in vehicle deformation zones was done. Using tube, oval and box-type structures, tests show that the occurring frequency ranges may be influenced. However, since the shock frequency is essentially influenced by the crash conditions, it seems to be doubtful whether it will be possible to sufficiently influence all frequency ranges by simply modifying at the body structure design. It appears more realistic to shift from ranges inferior to 150 cps to superior ones or vice versa. The range inferior to ten cps can only be tendentially influenced. It is also suggested that vehicles provide one or more filter elements between the passenger and the vehicle, which, regardless of the input, keep dangerous frequencies away from man. However, it will be almost impossible to substantially influence the basic frequency or to shift it to ranges of 20 cps and more, as there are only limited paths available as concerns both the vehicle structure and the vehicle interior.

by Ulrich Bez
Porsche Res. and Devel. Centre, Federal Republic of Germany
1976; 27p 29refs
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 570

INFLUENCE OF TIRE PROPERTIES AND REAR AXLE COMPLIANCE STEER ON POWER OFF EFFECT IN CORNERING

The interaction of longitudinal and lateral vehicle dynamics during rapid cornering and sudden speed reduction by powering-off can affect changed axle and tire load distribution, changes of the lateral forces and the self-aligning torque of the tires, and kinematic and elastic changes of the wheel position. The overall effect is oversteering, a turning-in of the vehicle into the curve caused primarily by diminution of the rear axle lateral force. Measures taken to control that driving situation are based on the supposition that in the case of an understeering reaction it should be possible to activate the lateral force reserves of the outer rear wheel by rapidly increasing the toe-in angle, immediately upon powering-off. Views of the elastokinematic swivel-axis rear wheel link concept (double wishbone suspension) are provided. The results of bench test examinations, driving tests and calculations show that it is possible to change the longitudinal force, justifying the further development of the elastokinematic wheel link concept. Tires were tested on the Porsche tire rig for transient input function--slip angle, longitudinal force and vertical load--and results of these as well as lateral force time histories are presented graphically. An experimental axle was designed and constructed, given bench tests with differing elastic and kinematic conditions, and driving tests on a European sedan with extensive adjustments of tires and rear axle. The testing proved that the elastokinematic concept can influence handling characteristics. The handling of the test vehicle was satisfactory though the rear axle had not yet been developed to its optimum level. After satisfactory tuning of the rear axle for powering-off it should be tuned for defined braking in the curve.

by H. H. Braess; G. Ruf
Porsche A.G., Stuttgart, Federal Republic of Germany
1976; 21p 7refs
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 571

E.S.V. 0EXPERIMENTAL SAFETY VEHICLE0 CONFERENCE. RENAULT STATUS REPORT

Renault recommends use of a test against a fixed barrier at a 30° angle. Renault studies on the distribution of fatalities with relation to impact severity have shown that classification based on the amount of energy dissipated only by the vehicle under study, without considering the characteristics of the obstacle, could only result in an erroneous understanding of reality, and they have developed an analysis method based on

on the political choice between active and passive restraints but would like to affirm that the air bag provides a gain in protection performance only in the case of the pure orthogonal frontal impact and for an occupant well centered in his seat, and that the air bag is not the best solution for small vehicles because of their short stopping distances and the increased time required to activate an air bag compared with that are car-to-car collisions against a fixed barrier. Renault suggests using an impact test between two identical vehicles while a suitable barrier is being developed and that two identical vehicles be used for lateral impact collision tests. If high levels of protection in this type of collision are to be achieved, technological solutions of huge consequences for the automobile will be required and this may effect the setting of severity levels and judgement criteria. For head impact criteria, Renault suggests raising the value from 1000 to 1500 based on current opinion of the survival limit and using tests based on real accident situations. They consider an attainable standard now better than a higher standard which can only be attained in the future. Regulations to increase pedestrian protection must be based on a logical analysis of real world road conditions and meaningful parameters of the mechanics of pedestrian impact and their consequences. Compatibility research should aim to define a method for verification and define a desirable compatibility level and should consider the statistical seriousness of the problem. Human impact tolerances also need to be considered including The effect of accidents on persons of different ages and sizes. It may be necessary to replace the present thorax deceleration criterion with a deflection criterion and to specify the tolerances for lateral impact.

by P. Ventre
Renault, France
1976; 14p
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 572

A METHOD OF ESTIMATING THE CRASHWORTHINESS OF BODY CONSTRUCTION

Experimental results obtained since the commencement of the Experimental Safety Vehicle (ESV) program are analyzed to introduce a new index, Residual Deformation (RD), for evaluating vehicle crashworthiness. The RD index, designed as a measure for estimating to what extent the car body affects occupant protection in a vehicle collision, can be easily determined from the crash stroke-time curve of the vehicle body. Calculations were made on this index, using a simple simulation model which illustrates the relationship between vehicle body and occupant injury. Comparison between the RD index and that of ride-down efficiency, a complicated index difficult of practical application giving the rate at which the body construction absorbs energy from the total occupant's energy, indicates that when the crash velocities are the same, the RD index can replace that of ride-down efficiency as a crashworthiness index. The use of the RD index illustrates a direct relationship between the vehicle front-end characteristics and RD index was confirmed to be effective in the evaluation of body characteristics.

by Shunji Matsui; Norimoto Aya; Hiroshi Nohsho
Vehicle Res. Dept., Nissan Motor Co., Ltd., Japan
1976; 18p
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 573

THE BEHAVIOUR OF VEHICLES AND OCCUPANTS IN ASYMMETRICAL FRONTAL COLLISIONS

The results of two two-vehicle accidents which occurred under similar conditions but which had very different results for the occupants are compared to study the parameters for protecting the occupants in asymmetrical collisions. In the first accident there were three parameters which were important for occupant protection: collision conditions, structural behavior, and behavior of the restraining devices. An offset collision increased vehicle deformation but reduced the mean deceleration and increased occupant-vehicle ride-down. There was high structural strength in the passenger compartment and good distribution of crushing forces from the front of the vehicle backwards. The restraining devices wholly maintained the free space in front of the occupants within the passenger compartments. The energy absorbers built into the shoulder belts were used to the fullest. In the second accident, collision conditions were not responsible for the lack of occupant protection since there were very close vehicle interference and angle conditions. Structural behavior was much more responsible since distribution of centers of gravity was not equal. A mathematical structure model used to simulate asymmetrical collision behaved comparably to real tests in an orthogonal collision but differed from real test results in a 30° barrier inclination test. Following the theoretical study, a practical and comparative analysis is made of vehicle passenger compartments in collision with the orthogonal wall and at 30°, comparing the vehicle deformation, the spacing effect of the engine block, the compression of wheels, and stress of the body side. Vehicle movements are compared between the two types of collisions. It was found that the collision at 30° highlighted the structural weakness of the body side much more than did orthogonal collision. However, penetration is not the only factor which causes accident seriousness: occupant trajectory is also critical and is described for both types of accidents. It was concluded that the 90° test with a fixed barrier is unduly severe and is not selective: a vehicle considered acceptable in such a test may be incapable of ensuring occupant protection in a real asymmetrical accident. The collision test with a fixed barrier inclined at 30° is a test capable of improving car safety because it allows the structural behavior in asymmetrical collisions which group together two-thirds of real frontal accidents

for better evaluation, and because it allows the protection afforded by the restraining device to be realistically appreciated.

by P. Ventre; J. C. Rullier; J. P. Verollet
Regie Nationale des Usines Renault, Res. and Devel. Dept., France
1976; 37p 8refs
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 574

SAFETY TEST PERFORMANCE LEVELS

Engineering development manufacturers have difficulty in establishing a practical design limit for safety test performance, as exemplified by calculation of clearance margins and design limits based on results of full-scale barrier crash tests of 33 airbag-equipped Mercury cars. In those tests averages of HIC (head injury criteria) and chest g of similar tests were well within the limits of the FMVSS 208 airbag requirements (480 and 37-39), but there was considerable scatter in results (both from laboratory to laboratory and within laboratories). Such variation, calculated by either the average difference between any two random measurements or by the prediction limit for the next single test, could result in a deviant result turning up in a compliance verification test and indicating nonconformance. To avoid such a possibility, the design limit would have to be placed well below the average value of the data. Thus a standard intended to impose only minimum requirements can end up imposing something more like maximum requirements because of the statistical variation in test results. Possible causes of the variation include test unrepeatability and random influences. The statistical procedure used in the test was the partially balanced incomplete block experiment design. Background discussions deal with design limits as being based on statistical tolerance limits and with test performance criteria as being analogous to specification limits.

by John Versace
Ford Motor Co., Environmental and Safety Engineering Staff
1976; 14p 2refs
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 575

DEVELOPMENT OF ADVANCED RESTRAINT SYSTEMS FOR MINICARS RSV 0RESEARCH SAFETY VEHICLE0

Protective features of the Research Safety Vehicle (RSV) compartment interior for the driver and front-seat passenger which provide protection levels of approximately 50 mph (tested both statically and dynamically) are a dual-bag concept and a force-limiting capability which enables occupant kinetic energy to be efficiently absorbed within the vehicle compartment, thus minimizing injury indices. The dual-bag concept is implemented in the driver restraint by two concentric (inner and outer) bags. The inner (torso) bag receives gas directly from the inflator and vents to the outer head bag. In the passenger restraint, a large partitioned bag is divided into an upper and a lower chamber. The lower chamber torso receives air directly from the gas inflator and vents to the upper head chamber. Protection for the out-of-position child is provided by a special bag-folding technique to reduce effective bag mass, low inflator mount, proper adjustment of inflator down angles for bag impact at child's center of gravity, and a recoil absorber. Force-limiting in the driver system occurs in the telescoping of the steering column. In the front passenger restraint it occurs in the stroking of the right side dashboard. Force-limiting was also incorporated into the RSV rear seat three-point restraint system to extend occupant protection capability approaching 45 mph with retractors, which exceeds that provided by conventional belt systems. RSV occupants are protected in side impact and rollover accidents by the strong shut faces and secure door latches of the gullwing doors as well as the well-padded, roomy interior and the fixed side glazing. Vehicle-to-vehicle side impact test results indicate that RSV near and far side occupants would receive minimal injury in a 35 mph impact with a vehicle of the Pinto weight class.

by Charles Strother; Michael U. Fitzpatrick; Timothy P. Egbert
Minicars, Inc., Engineering Staff
1976; 35p
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 576

CRASH TEST PERFORMANCE OF RENAULT BASIC RESEARCH VEHICLE

The results from two crash tests performed on a Basic Research Vehicle (BRV) developed by the Renault Motor Company show that only minor injuries would have been inflicted on human occupants in either test. The BRV appears to provide a level of occupant protection adequate to satisfy safety criteria and standards currently in use in the U.S. for the given test conditions. The first test included a 30° frontal oblique rigid barrier crash at a speed of 42.5 mph; and a second test, a 75° side impact of the same BRV by a standard production Renault R-12 vehicle at a speed of 31.3 mph. Of the two tests, the angled barrier was the more severe and imposed the greatest degree of damage to the vehicle, both in exterior crush and deformation to the occupant compartment. Although the responses of the test dummies were below accepted tolerance levels, sufficient structural deformation occurred in the barrier impact to cause both doors to be jammed shut. This could create a problem in extracting incapacitated victims of a crash from the vehicle. There was some intrusion into the occupant compartment in the barrier test and the seats moved forward a small amount; however, these are both minor effects considering the severity of the impact and are not believed to have significantly increased the hazard to the occupants. Figures and tables illustrate various phases of the tests.

by Rudy H. Arendt
Calspan Corp.
1976; 23p 2refs
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

lap-torso belt restraint systems. In these studies candidate restraint systems were analytically evaluated in specific vehicle acceleration environments prior to the performance of sled tests of actual hardware. The model of the crash victim consists of 15 segments and 14 joints to represent the human body. Measurements of vehicle interior geometry provided the data for simulation input. The RSV base vehicle, Simca 1307, and the vehicle selected for installation of the aspirated air bag system, Volvo 244 DL, were selected for input measurements of mutual force-deflection characteristics for the occupant contact plane. Sets of cold gas inflation systems input parameters had to be developed from existing data from an inflation system containing a pyrotechnic hot gas generator. Adjustments were made in measurements of the air bag to provide the correct volume for simulation. Twenty-three simulation runs and three sled runs were made in the RSV Program. In the aspirated air bag inflator program, a 50-lb simulated child occupant was used, along with a simulated seated 50th percentile male occupant. Seven simulations were performed, and results from one sled test showed the test configuration closely matched the input of a simulation run. In the belt restraint system simulations RSV program, a limited series of runs simulating the 35-mph barrier crash of the C-6 base vehicle was performed. A 1975 Plymouth lap/shoulder belt system was used on a front seat passenger Part 572 dummy. Results provided confidence in the predictive capability of the CVS in a planned series of parameter variation runs. In the advanced belt system development most of the input data used remained intact throughout the study. Changes were those mandated by geometrical design or by addition of new restraint system components. The effects of intrusion were incorporated by performing several runs with various positions of the dashboard. The results of the belt restraint system simulations indicate good correlation between the measured responses and the predictions of these responses by the CVS model. A small number of impact sled validation tests were run employing dummies in a restraint system resembling the simulated belt systems to provide validation data for the CVS program configuration used in this study. The results were not as good as the baseline validation runs because of an inability to simulate the actual restraint properties with input describing the inflated belt characteristics in terms of equivalent webbing elongation. Measurements such as these involve elaborate experimental efforts beyond the scope of this validation effort. Recent validation efforts to explain and eliminate phase disagreement have been performed. In one such program, BAGFIL, particular attention was paid to the development of improved descriptions of parameters related to choices for the CVS bag inflation and venting algorithms and bag deployment geometry, thought to be the causes of phase shift. The results of BAGFIL show the measured head and upper torso displacements to be in much closer agreement with predicted values than were previous simulation results. Future plans call for programs to

1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 578

CRASH TEST PERFORMANCE OF BRITISH LEYLAND MARINA SAFETY RESEARCH VEHICLES

Two recent car-to-car crash tests of Phase I Marina Safety Research Vehicles (SRV) developed by British Leyland Motor Corporation included a central head-on collision of a Marina SRV with an AMF experimental safety vehicle at a closing speed of 60 mph, and a 90° side impact of the Marina SRV by a modified production Marina automobile at a speed of 30 mph. The objective of the test program was to evaluate the safety performance of the Marina SRV's from the vehicle and occupant responses measured in the crashes. In the head-on collision, two 50th percentile male dummies occupied the front seats of the Marina SRV. In the side-impact crash test, two 50th percentile dummies were placed in the front seats of each vehicle. To avoid the loss of data due to equipment failures, redundancy in the data gathering system and dual recording of such data was provided and proved an effective and valuable safeguard with the result that no data of major significance were lost in any of the tests. Based on current injury criteria, the test results indicate that human occupants likely would have sustained only minor, if any, injuries in either in the collisions.

by Norman J. DeLeys
Calspan Corp.
1976; 17p 3refs
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 579

INFLUENCE OF MATERIAL RESOURCES ON THE RSV 0RESEARCH SAFETY VEHICLE0

The Research Safety Vehicle (RSV) program relative to automobiles appropriate for the U.S. economy in the latter 1980's describes a vehicle of family size for 4 to 5 occupants, with 14 to 19 cu ft of cargo volume, having four doors and a liftgate. The engine drivetrain must fit lateral dimensions without adding length and must avoid compromising crashworthiness. At present the Chrysler Simca 1308, not presently manufactured in the U.S., best fits these characteristics. The future of materials such as aluminum, columbium, nickel, and possibly iron will have the greatest impact on construction components of the 1980's automobile. Weight reduction is advocated for fuel economy. Future cars must be recyclable. Because present recycling methods present problems such as increased costs in transportation of bulk and shredded scrap, the need for new capital to make improvements in equipment to adapt to the changing composition of cars, and metallurgically difficult separations of ferrous and other elements as car

of the scrap and elimination of seat wires which, with cables, tend to block air separation chutes. Further, recovery costs increase because of the dilution of nonmagnetic metals by rubber, heavy plastic and other debris. The following points will characterize the 1980's automobile as shown in the RSV: some additional weight in bumper and door structures (about 200 lbs) will be added; the use of plastic will increase while the use of aluminum will be downgraded because of limited supply and the difficult recovery in recycling; the use of HSLA will be increased because of its easy recoverability, lighter weight, improved strength, and crash energy-absorbing characteristics; no chrome will be used because it is difficult to recycle and the U.S. is dependent on foreign markets for its supply; dissimilar metals will not be joined because of separation problems in recycling; and design changes will be incorporated providing they present no recycling problems.

by Patrick M. Miller; Frank A. DuWaldt
Calspan Corp.
1976; 32p 14refs
Presented at Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 580

CALSPAN/CHRYSLER RESEARCH SAFETY VEHICLE FRONT END DESIGN FOR PROPERTY AND PEDESTRIAN PROTECTION

Because over 20% of traffic fatalities in the U.S. are pedestrians, and because little protection is offered the pedestrian by automobiles whose exterior design is dictated by exterior damage protection requirements, a soft front bumper system was developed to provide improved levels of pedestrian protection and exterior vehicle damage protection. A protecting vehicle design must be effective up to a speed slightly greater than 20 mph, located on the front of the vehicle, designed to protect and minimize head and lower extremities of the pedestrian and to prevent hard contact with the ground or windshield structure. It should pick up the pedestrian and carry him along until the vehicle stops while minimizing upward and rearward projection of his body. Damage caused by collisions at less than 10 mph counts for the bulk of total repair costs, and damage to fronts of vehicles is involved in almost all vehicle-to-vehicle collisions. To meet these pedestrian and vehicle requirements, the soft front bumper made of a flexible fascia filled with a low density energy-absorbing urethane foam, with a collapse pressure of about 20 psi, was designed and found to reduce damage at low speeds. Further, it is compatible with pedestrian protection objectives. Four bumper shapes were tested through computer simulation of pedestrian impact using the CAL-3D crash victim simulator. The best performance occurred with the shape which matched the pedestrian's forward velocity closely with that of the vehicle and positioned him over the hood of the car without pitching him high into the air. Further simulation tests showed that a soft bumper collapse pressure of 20 psi with a resultant deformation of 5 inches provides the greatest degree of modified Simca C-6 front structure along with male and child dummies. Results are still to come.

by Wayne L. Kruse
Chrysler Corp.
1976; 30p 8refs
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 581

REALISTIC COMPATIBILITY CONCEPTS AND ASSOCIATED TESTING

Using simulation computations, Volkswagen tested concepts of compatibility between large and small vehicles to determine the capacity for energy absorption allowed in head-on and fixed barrier collisions, as well as the appropriate closing velocities as a function of the mass ratio. They decided that the constant permissible closing velocity is independent of mass ratio and, further, that this concept exploits the bigger vehicle's capacity for energy absorption to the fullest extent. Furthermore, they found that occupant safety can be guaranteed in a collision at a constant closing velocity up to 71 mph and mass ratios of up to two. Both vehicles had a maximum fixed barrier impact velocity of 40 mph related to the energy absorption capacity. However, if the mass ratio should go beyond two, the mean deformation force of the bigger vehicle remains constant with increasing mass ratio and at the same time, the velocity change of the smaller vehicle remains constant. Unusual vehicle geometries, such as an excessively long vehicle front, were not found necessary when deformation force increased the mass ratio to 1/2. Tests were performed to prove experimentally that this concept can be implemented in vehicles of conventional design, and that a movable deformable barrier may be used to simulate the deformation characteristics of one of the two vehicles involved in a collision. The two vehicles used were the Experimental Safety Vehicle (ESV) VW II (2,200 lbs) and a Ford LTD (4,400 lbs) with the engine mounted on the chassis frame located as far toward the vehicle rear as possible to ensure favorable deformation behavior with the smaller vehicle. Test 1 was the frontal impact of the ESVW II on a fixed barrier at 40 mph to demonstrate that the smaller vehicle will guarantee the safety of its occupants in a frontal collision with a fixed barrier at 40 mph. The test so demonstrated. Test 2 determined the forcestroke characteristic of the deformation zone of the vehicle tested by means of the deceleration measured at the movable nondeformable barrier. These characteristics were then used as a basis for adjusting the deformation elements of a movable deformable barrier to simulate the mass of a vehicle and its frontal structure. The Ford LTD was used. Test 3, frontal impact on a movable deformable barrier, determined the deformation behavior and the degree of occupant safety offered by the movable deformable barrier simulating the Ford LTD. Test 4, the frontal vehicle-to-vehicle collision, was performed to prove that occupant safety is guaranteed at a collision speed of 71 mph and a mass ratio of 2. Such safety was guaranteed for the driver and front-seat passengers of both vehicles. Compatibility of the two vehicles was established by the fact that

1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 582

COMPATIBILITY OF PASSENGERS CARS IN ROAD ACCIDENTS

In a study of the compatibility of passenger cars in road accidents, a three-mass model simulating the frontal collision of two cars is presented; and a numerical determination of compatibility is developed. Vehicle to vehicle collisions were selected because they occur much more frequently than road frontal impacts against fixed obstacles. Injury severity depends on some collision parameters such as variation of car velocity, mean car acceleration and passenger compartment intrusion. From road accident data involving unrestrained car occupants the probable injury severity expressed in AIS (Abbreviated Injury Scale) classifications is related to the collision parameters using the method of multiple regression. The parameters in turn are determined with a mathematical three-mass model from the initial car velocities, the car mass ratios and the front end crush resistance characteristics. A compatibility index proves useful for assessing compatible crush resistances. Further investigations, it is stated, are needed in particular with regard to restrained car occupants. Compatibility throughout the entire car population is only achievable if the crush resistances of all cars are tuned to the optimal crush force level combination necessary for the most frequent mass combination of colliding cars. Within the range of tolerable crush, heavier cars have a safety reserve which is larger, the larger the mass ratio is. Levelling of the injury risk in cars of different weight by adequate selection of crush resistance is impossible, if equal effectiveness of restraint systems is assumed (compensation of higher risk due to low car weight by higher restraining performance). At high impact speeds the injury risk can be smaller in each of two cars with unequal crush resistance compared to cars with equal resistance.

by Willi Reidelbach; Walter Schmid
Daimler-Benz A.G., Res. Dept. Passenger Car Body, Sindelfingen, Germany
1976; 20p 1ref
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 583

THE STATUS OF THE JAPANESE ESV 0EXPERIMENTAL SAFETY VEHICLE0 PROGRAM

In the autumn of 1973, the first ESV's were delivered to the Japanese Governmental Agency for evaluative testing by Nissan and Toyota. The tests were conducted by the Japan Automobile Research Institute, Inc. (JARI) in the spring of 1974. Presently, Japanese ESV projects are seeking to make technological advances in order to realize further improvement. Attention will also be focused on the education of both motorists and the general public.

by Takeaki Koyanagi
Ministry of International Trade and Industry, Japan
1976; 5p
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 584

STATUS REPORT OF THE FEDERAL REPUBLIC OF GERMANY 0TRAFFIC SAFETY0

In connection with the ESV (Experimental Safety Vehicles) activities, the West German federal government presented in 1973 its comprehensive Traffic Safety Program. Apart from the activities in the fields of traffic education and traffic information, some measures, provisions and regulations which have been introduced include wearing of seat belts by every front seat occupant (made into law 1 Jan 1976); a speed limit of 100 km/hr for all roads with less than two traffic lanes in each direction (1 Jan 1976); a general 130 km/hr recommendatory speed limit on highways (March 1974) with a corresponding study being made to evaluate the effects of a strict 130 km/hr speed limit (results expected in 1977); obligation to switch on directional signal also at end of an overtaking maneuver (1 Jan 1976); switch on hazard warning signal for school buses when children alighting or boarding (1 Jan 1976); children under age of 12 not allowed on front seats of passenger motor vehicles (1 Jan 1976); gradual equipping of all passenger motor vehicles registered after 1 Apr 1970 with seat belts (1 Jan 1976); wearing of helmets by motorcyclists and passengers (1 Jan 1976). Currently head rests on front seats of passenger motor vehicles and types of glass for windscreens are being evaluated. Related to the objectives of the RSV (Research Safety Vehicles) project which is the continuation of the ESV project, the environmental impact of vehicles is being studied; and by 1980, the pollutant emission of vehicles with Otto (controlled ignition) engines is to be reduced to one-tenth of the 1969 mean values. The Federal Highway Research Institute (Bundesanstalt fuer Strassenwesen) is now the central agency for road accident research. The ideas and experience of the German Traffic Safety Council are incorporated into the planning framework for research. The German motor vehicle insurers (the HUK association) conduct accident research representing one of most comprehensive studies in the world. The objectives of studies in accident prevention and the search for new technologies (the main areas being propulsion systems; fuels and other energy sources; and vehicle, equipment, and safety technologies) are outlined.

Federal Republic of Germany
1976; 8p
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 585

STATUS REPORT BY THE UNITED KINGDOM MOTOR VEHICLE INDUSTRY 0SAFETY, ENERGY, ENVIRONMENT, AND ECONOMY0

The views of the United Kingdom (U.K.) automobile industry on safety, energy, environment, and economy are presented, and the current status of these four objectives is outlined. Graphs are given which show the trend of engine capacities for new vehicle registrations for 1970-1975 (vast majority having capacities of 1000 ccs and 2000 ccs) and curb weight of current U.K. vehicles below 2000 cc engine capacity (most below 1000 kg or 2200 lb, the RSV (Research Safety Vehicles) program for a safety car being 1364 kg). Tabulated data are given for tests (48 kmh frontal barrier impact, rear impact, roof) performed by car manufacturers which relate to EEVC (European Experimental Vehicles Committee) recommendations. The motor industry is continuing to study the objectives of the EEVC, and so far it seems that the EEVC recommendations are practicable and would not have an unacceptable effect on total vehicle price providing that the benefits can be demonstrated. For these reasons the U.K. motor industry is not pursuing the RSV concept further but is following the EEVC objectives. The U.K. along with most other European countries has or will shortly enact laws requiring the wearing of safety belts (tabulated data presented). Some of the customer problems related to safety belts are outlined, and ways some manufacturers have overcome these problems are discussed (photographs of persons wearing safety belts illustrate problems which existed and how they were solved). Conservation and applications of the different forms of fuel are discussed. It is emphasized that petroleum fuels should be conserved for road transport and for portable power applications, and that vehicle weight is the principal factor governing the total amount of energy used. Tabulated data show fuel consumption for the U.K., EEC, U.S.A., and Japan. In relation to the environment, air pollution (tabulated data given for sources of air pollution in the U.K. for 1972) and noise pollution (tabulated data given for existing and proposed legislation to control the noise emitted by new passenger cars in the EEC, Japan, and U.S.A.) are discussed. Legislation to reduce motor vehicle pollution was introduced in the U.K. in 1972, with full effects of this not to be seen until the 1980's. The car industry is against further lowering of the limits of exhaust gas emissions until a European air quality standard is established, and problems which will result if limits are lowered are discussed. With regard to noise pollution, the U.K. legislation is in abeyance. It is recommended that test methods to measure noise should be internationally standardized. With regard to economics, weight control of vehicles is of utmost importance. More sophisticated design analysis methods can show areas where savings can be made, but more obvious methods involve the use of alternative materials such as high strength low alloy steels (HSLA), aluminum and plastics. Vehicle weight reductions give economics in running costs and the consumption of materials, and the motor industry recommends that government agencies in all countries review current and proposed legislation to ensure that its effect on vehicle weight is minimized.

Society of Motor Manufacturers and Traders Ltd., England
1976; 31p
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 586

A SUMMARY OF THE MINICARS RSV 0RESEARCH SAFETY VEHICLES0 PROGRAM

With the conclusion of Phase 1 of an RSV (Research Safety Vehicles) contract which entailed projecting the automotive environment of the mid-1980's (types of vehicles, performance specifications of vehicles, an RSV preliminary design to satisfy specifications), Phase 2 was undertaken in which all of the vehicle systems were to be developed, tested, and integrated with each other; and the results of Phase 2 are summarized here. It is stated that the Minicars RSV meets the S3E (energy, environment, and economy) concept introduced by Dr. James B. Gregory, former Administrator of NHTSA, in that it demonstrates that national goals for safety, fuel economy, and emissions can be compatible, and can all be met with a producible, marketable, and relatively economic package. Topics of discussion in this report include marketability and producibility; maximizing the safety payoff; effects of weight; the Minicars approach to achieving program objectives (accident analysis findings, RSV front structure optimization, designing for minimum weight, RSV structural design, RSV occupant protection); features of the Minicars RSV in addition to its low weight, low emissions, low fuel consumption, and high safety performance (vehicle architecture, powertrain, electronics, running gear, plastic and glass systems). Tabulated data give distribution of societal costs by accident mode and velocity; distribution of unrestrained occupant societal cost by damage area and impact force for vehicle-to-vehicle accidents; 75th percentile closing velocities for societal cost along with impact speeds actually used in testing; comparison of weight, size, and accommodations by the RSV, Maverick (4-door) Pinto, and Honda Accord.

by Donald E. Struble
Minicars, Inc.
1976; 40p
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 587

RESEARCH AND DEVELOPMENT TOWARDS IMPROVED PROTECTION FOR PEDESTRIANS STRUCK BY CARS

Descriptions, results, and comments are given for car impact tests on pedestrian dummies representing adults and six-year-old children, and details of these impact studies are given in tabulated form. It is concluded that the severity of primary impact is reduced by maintaining the collapse characteristics of the front of the car to the appropriate human tolerance loads. An adult pedestrian should be picked up and retained on the hood over as wide a range of impact speeds as possible without being projected over the roof or wings to the ground. A child should be picked up onto the hood or hood front rather than knocked forward to the ground. The head should impact a suitably designed energy absorbing hood top rather than the more rigid windshield surround. Some features of vehicle design that contribute to these conditions include a low mounted energy absorbing bumper with a yield of at least 100 mm, an energy absorbing hood leading edge with a yield of at least 150 mm, and hood and wings with controlled vertical collapse characteristics. The height of the leading edge of the hood has conflicting requirements. It needs a low hood front

for projecting a child on the hood and a high hood front for reducing the frequency of adult head impact with the windshield surround. A long hood also reduces this latter possibility. Accident statistics in Great Britain for 1974 show that about 40% of road fatalities and about 25% of seriously injured persons were pedestrians.

by J. Harris
Department of the Environment, Transport and Rd. Res. Lab., Crowthorne, Berks., England
Rept. No. U.K.-Contrib-PA248/76; 1976; 19p 5refs
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 588

LILAC--LOW INTENSITY LARGE AREA CITY LIGHT

Two systems for controlling vehicle headlight intensity to provide a "town beam" for use in lighted streets known by the generic name of LILAC (Low Intensity Large Area City Light) have been developed to meet the recommendations of the CIE (International Commission on Illumination) for "a town beam which is intermediate in intensity between that of the currently used low beam and sidelights. Such a light should have a luminous intensity between 50 and 100 cd and should have an area similar to that of current headlights." In Great
on streets
pedestrian
m for con-
consisting of a
hich was first proposed in the early
r is a recent development of an automatic
ntrols headlight intensity automatically to suit the ambient street lighting. One thousand of the automatic version are about to undergo evaluation tests in city traffic conditions. If these tests are successful, it is hoped that the system will be generally adopted as it will provide the optimum vehicle front lighting system for all conditions of night driving, whether on well-lit roads, on poorly lit roads, or on unlit roads.

by J. A. Reid
Department of the Environment, Transport and Rd. Res. Lab., Crowthorne, Berks., England
Rept. No. U.K.-Contrib-PA247/76; 1976; 13p 3refs
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 589

TRAFFIC ACCIDENTS TO CARS WITH DIRECTIONS OF IMPACT FROM THE FRONT AND SIDE

The main accident sample of United Kingdom frontal and side impacts is that collected between 1970 and 1974 by the Accident Investigation Division at the Transport and Road Research Laboratory (TRRL), specifically data on impacted cars or car derivative vans where full information is known on all the people involved in an accident, whether injured or not (about 500 impacted cars and 1000 occupants). Statistical data are presented in tabular form and include directions of impact in accidents occurring in Great Britain, France, West Germany, and Italy; sites of impact; and severity and distribution of injuries to occupants of vehicles involved.

by B. S. Riley; C. P. Radley
Department of the Environment, Transport and Rd. Res. Lab., Crowthorne, Berks., England
Rept. No. U.K.-Contrib-PA257/76; 1976; 19p 4refs
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 590

EXPERIMENTAL PROGRAMME ON FRONTAL IMPACT TEST PROCEDURES. PRELIMINARY REPORT

Frontal impact studies as part of the United Kingdom's co
tribution to the development of European car safety standar
consist of a series of full scale impact tests using three c
models of similar mass but distinctive layout: the Leyla
Marina (conventional layout), the Leyland Allegro (fro
drive), and the Volkswagen Beetle (rear engined), each havi
similar mass. Car-to-car head-on impacts with 40% overlap ar
a series of tests using partial and angled barriers were co
ducted. All cars were moving at about 50 km/h. Both the ca
to-angled barriers (steel faced and 30° to head-on) and car-t
offset barriers with radiused edge reproduce reasonably we
the damage to cars seen in the car-to-car impacts with 40%
overlap. Car front structures tend to be forced away from th
site of impact in car-to-angled barrier tests but to be pulle
around towards each other in the car-to-car and car-to-offse
barrier tests. For angled barriers, the car front face tends t
slide along barrier face and not to be brought to rest at poin
of impact; and the car has a reduced change in velocity com
pared with car-to-car impacts which result in a reduction i
impact loadings measured on the test dummies. These reduc
tions are probably greater for a narrow steel faced angled bar
rier because cars can slide around the side of the barrier past
the rear edge of the front face. In all cases the tests of cars
into offset barriers with suitably rounded edges gave good
representations of car-to-car impacts though the results at low
overlaps appear to be sensitive to the match between the par-
ticular percentage overlap, the edge radius and the detailed
front structural design of the car. In the car-to-barrier and to a
lesser extent in the car-to-car impacts, the VW Beetle showed
a marked tendency to glance off the vehicle it impacted at the
degrees of overlap tested, a tendency much stronger than
found in the other two models tested. This resulted in lower
velocity changes for the occupants. The standard inertia reel
seat belts used for the front seat dummies were of one design
which generally performed correctly with belt loadings for 50
km/h impacts and which were generally acceptable in esti-
mated tolerance levels. In the two OPAT (Occupant Protection
Assessment Test) dummies used in 16 50 km/h impacts, one
femur load cell has been the only component requiring repair.

by R. N. Kemp; I. D. Neilson; J. G. Wall
Department of the Environment, Transport and Rd. Res. Lab., Crowthorne, Berks., England
Rept. No. U.K.-Contrib-PA252/76; 1976; 12p 4refs
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 591

THE DETERMINATION OF TOLERABLE LOADINGS FOR CAR OCCUPANTS IN IMPACTS

The methods used at the Transport and Road Research Laboratory (TRRL) in England to determine tolerable loadings for car occupants in impacts are based on correlating injuries received by living human car occupants in accidents with measurements made on dummies or test devices suitable for research or approval testing in laboratory simulations of these accidents. Where suitable accident data exist a statistical technique is used which enables the proportion of the population at risk who will suffer injury at any given level of loading to be predicted. Predictions of the effect in terms of injury incidence to the population can be made for any level of load limitation. These predictions may be used in forming regulations and to guide the design of vehicle systems (e.g. occupant restraints). Investigations measuring the loadings produced by a seat belt, the knee/thigh/hip loading resulting from knee impact with the fascia, and loadings on car occupants in side impacts are discussed. Accident chest injury data and shoulder belt tensions measured experimentally with an OPAT (Occupant Protection Assessment Test) dummy and data giving predicted incidence of skeletal hip injury in three models of car are presented in tabular form.

by J. Wall; R. W. Lowne; J. Harris
Department of the Environment, Transport and Rd. Res. Lab., Crowthorne, Berks., England
Rept. No. U.K.-Contrib-PA242/76; 1976; 17p 10refs
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 592

ACCIDENT STUDIES RELATED TO VEHICLE SAFETY

Past research in primary safety in the United Kingdom has established such main priorities as improved tire and brake maintenance, anti-lock devices for cars and motorcycles, and greater conspicuousness for riders of two-wheeled vehicles. Also, a greater understanding has developed of secondary safety needs and of the mechanisms by which injuries occur. A four-year multidisciplinary study was completed in 1974 which considered vehicle defects and loss of control while braking as factors in accidents in a given study area. A current study of patterns of vehicle injuries is multidisciplinary and deals with restrained and unrestrained vehicle occupants, considering also the noninjured occupants and seat belt effectiveness. Future research is needed in human tolerance levels and the relationship of vehicle design changes to risk of injury. Proposed projects include combined at-the-scene and injury studies concentrating on crash reconstruction, and intermediate level studies on a nationwide basis.

by Barbara E. Sabey
Department of the Environment, Transport and Rd. Res. Lab., Crowthorne, Berks., England
Rept. No. U.K.-Contrib-PA254/76; 1976; 11p 10refs
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 593

STATUS REPORT ON EXPERIMENTAL SAFETY VEHICLE DEVELOPMENT PROGRAMME

The ESV (Experimental Safety Vehicles) development in the United Kingdom began with the development of component systems that would be suitable for early incorporation in production cars, and chose vehicles in the 860-1300 kg (1900-2800 lbs) weight range having engines of 1000-1800 cc capacity which have relatively low fuel consumption. Since the last ESV Conference in 1974, the British program has concentrated on safety matters, notably car occupant safety in side impacts and the design of car fronts to minimize injuries to pedestrians in the event of impact. It is believed that the front bumper should be below the current U.S.A. legal requirements and at a height compatible with the height of car door sills, leading to front end designs in which impact injuries to pedestrians would be minimized and severity of injuries to occupants of cars in side impacts would be lessened. Accident investigations continue to play an important role in the British program. It is believed that changes in design of steering and braking systems of European type cars would play little part in reducing accidents. Automatic leveling of headlights and improved performance from dipped headlights may tend to reduce nighttime accidents. The use of seat belts has increased, and the development of better and more comfortable types (3-point lap and diagonal type equipped with emergency locking retractors) has occurred. A type of glass known as "Triplex Ten Twenty" to minimize lacerative effects to car occupants caused by broken windshields is now in use. The "run flat" concept of tire and wheel equipment intended to abolish the need for a spare wheel and tire, provide greater luggage space and less weight, and minimize loss of control in case of sudden puncture, has been developed and is available as optional equipment. Close collaboration between British and other European governments continues under the auspices of the EEVC (European Experimental Vehicles Committee); and work is about to commence on improved procedures for impact testing utilizing performance standards which can be related to available biomechanical data and real life accidents. The British car safety program has shown that worthwhile improvements in safety and convenience to car occupants are feasible without the need to increase significantly vehicle weight or costs and without lowering environmental standards. An attempt to develop worldwide regulatory standards for vehicle safety is thought to be timely.

by J. W. Furness
Department of Transport, United Kingdom
1976; 3p
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 594

EFFECTIVENESS OF ATD'S 0ANTHROPOMORPHIC TEST DUMMY0 AND CADAVERS IN EVALUATION OF RESTRAINT SYSTEM

The results of cadaver and ATD (anthropomorphic test dummy) tests with a variety of restraint systems, but primarily with 3-point belts, are examined. Response measures and restraint loads are compared with respect to these same measures for similar test exposures. From these studies, cadaver and ATD response measures appear to be generally equivalent

chest and head resultant accelerations by AIS ratings are sufficiently sensitive that the performance of distributed load restraints (e.g. air belts, air cushions, bag-bolsters) can be distinguished from that of three-point belt restraints. This distinction is improved when body area AIS ratings are used rather than overall ratings. The use of cadavers as surrogates must include autopsies in order to adequately assess injury. Therefore, there should be no multiple use. Their most appropriate use, in restraint system evaluation, is to establish limits of protection. Such employment, in conjunction with ATD's, should provide good predictions of human performance.

by Edwin A. Kidd; Michael J. Walsh
Calspan Corp.
1976; 26p 27refs
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 595

REVIEW AND CORRELATION OF DRIVER/VEHICLE DATA

Open and closed loop data are used to infer the behavior (e.g. reaction time, time to peak, settling time; peak amplitude, ratio of peak amplitudes, maximum rate) of drivers in various driving tasks (e.g. single and double lane changes, turns, and exits, slaloms) and to determine the manner in which vehicle factors (e.g. yaw velocity response to steering wheel input, axle load ratio, stability, oversteer/understeer gradient) influence this behavior. Procedures are presented for establishing and predicting satisfactory or unsatisfactory vehicle performance regions and limits germane to driver/vehicle dynamic performance. Implications from the data are used to tentatively identify safety-relevant vehicle performance characteristics, requirements, and criteria to provide guidance for future test programs.

by David H. Weir; Duane T. McRuer
Systems Technology, Inc., Hawthorne, Calif.
1976; 9p 8refs
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 596

EFFECT OF HIGH PRESSURE HYDRAULIC SYSTEMS ON PRIMARY SAFETY

Features developed and adopted by Citroen in order to increase the qualities of active safety of their compact and full-sized vehicles involve application of high pressure hydraulic engineering in mass production of its vehicles. High pressure hydraulic systems were introduced in 1953 on the rear axle suspension of the 15 Six H vehicle, and these systems have been applied to suspension and brakes of such vehicles as DS, sure, small volume of gas springs under high pressure, and a almost unlimited lifetime of working parts because parts ar separated by a film of oil constantly under pressure. Contribu tions of the hydraulic systems to primary safety include an ex tremely high level of comfort and possibility of backing u components whose control requires an appreciable strength thus reducing user's fatigue; a very good capacity of road han dling; a particularly fast response time of the braking control good retention of brake efficiency; possibility of fast maneu vers of vehicle due to quick steering response; and main tenance of the steering angle selected by the driver whateve the external circumstances.

Citroen Car Corp., France
1976; 17p
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 597

CONFERENCE ESV DE WASHINGTON. STATUS REPORT (ESV 0EXPERIMENTAL SAFETY VEHICLES0 WASHINGTON CONFERENCE. STATUS REPORT)

In an effort to understand the nature and the force of collisions by vehicles and their occupants during accidents, a photographic library ("phototheque") of controlled shocks was used to allow investigators to study the deformation of a vehicle after an accident with reference to a collection of photographs which show deformations sustained by the same make of vehicle after colliding with obstacles (walls, posts, mobile barriers) at known speeds. An examination of photographs allows one to know directly by interpolation or extrapolation the speed of the vehicle at the moment of impact, and also one can simply deduce the two principal parameters of shock sustained by the car occupants, the change in speed, and the mean deceleration. With regard to a crash of two vehicles, the photographic library permits one to determine for each vehicle, the equivalent speed of a collision against a rigid obstacle which gives a deformation of the same nature as that observed in the field. The knowledge of the masses of the two vehicles and a comparison of their centers of gravity after deformation permit one to know the actual speeds at the moment of impact and then to know the change in speed and the mean deceleration of each of the vehicles. In an effort to protect passengers in case of frontal impact, studies are being carried out on the behavior of materials and structures in high-speed deformation, the efficiency of restraint systems (especially belts), and the angle and speed of impact. The necessity for experimental vehicles and progress being made in this field are reported; and other research in progress on lateral collisions, protection of occupants in urban collisions, the aggressiveness of vehi-

cles, and the protection of pedestrians and children in vehicles is discussed.

by Michel Frybourg
Institut de Recherche des Transports, France
1976; 8p
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977. Text in French.
Availability: Corporate author

HS-019 598

STATUS REPORT 0TRAFFIC SAFETY, PEUGEOT0

From the standpoint of the most important aspects of study with regard to traffic safety, Peugeot presents trends and results of experimental studies on frontal impact, side impact, and pedestrian protection. With respect to frontal impact collisions and the wearing of seat belts, studies have included investigation of front structures whose deformation laws in the various types of frontal impact provide an optimum protection level for belted occupants; study of the influence exerted by belt characteristics upon the protection level (rigidity, initial play, anchorage geometry); improvement of belt comfort; determination of accident actual severity based on speed variation and vehicle mean deceleration and selection of the frontal impact test procedure; participation in the foundation of a national photo library whose utilization should permit estimating accident force; and biomechanical research, especially as concerns head and thorax tolerances. With respect to lateral impact collisions, a sample of data on lateral collisions which has been gathered is big enough to permit evaluating correctly the actual impact conditions as well as their severity; for biomechanical research, the head-neck segment of currently proposed dummies is in no way adapted to the lateral impact configuration; and a compromise between the level of reduction achieved for occupant compartment intrusion and the level of protection provided for interior walls is being investigated. As far as regulations in the area of lateral impact, it is suggested that in the short run, there should be an improvement in the resistance to intrusion on car sides; in the medium run, the specific aggressiveness of any new car should be limited; and in the long run, a deformable moving barrier may be substituted for a vehicle to act as an obstacle in studies. With respect to pedestrian protection, investigations have shown that the most severe injuries are caused by the impact of the head on the vehicle and injuries brought about by the second impact against the ground appear less severe than previously supposed. Therefore, priority has been given to the study of the possible improvements in the dashboard area and the implantation of the windshield frame. It has also been shown that the bumper has no preponderant influence on the severe or fatal injuries of impacted pedestrians.

by Jacques A. Desbois
Centre d'Etudes de Paris des Automobiles Peugeot, BP16, 92250 La Garenne, France
1976; 8p
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 599

PRESENT STATE OF JAPANESE AUTOMOTIVE INDUSTRY FROM VIEWPOINT OF SAFETY TECHNIQUE DEVELOPMENT

The Experimental Safety Vehicles (ESV's) of Nissan and Toyota were completed at the end of 1973 and were tested by the Japan Automobile Research Institute and by Ultra System Corp. in the U.S. Honda also developed ESV's which were subjected to internal company testing. Even after completion and testing of ESV's with test results published or presented, parts of the systems developed in relation to ESV's have been made subjects of further study. As a result of the ESV program, technical developments were made in the areas of vehicle body construction, occupant protection, accident avoidance, and warning systems. In addition, indirect accomplishments of the program include stimulus to and promotion of studies concerning safety in human engineering applications; improvement and accumulation of experimental and evaluation techniques in the field of safety; and enlargement of safety facilities such as a J-turn test course, and more complete testing equipment. Some of the problems currently confronting the Japanese automotive industry include emission control standards, road traffic noise level, conservation of natural resources, and energy saving. It is pointed out that improvements have not only been made in automotive safety but also in the safety of the entire motor vehicle environment (motor vehicle safety laws recently passed are listed). Future areas for development of safety techniques include occupant protection systems, body and compartment construction, pedestrian protection, vehicle brake performance and maneuverability, and visibility and light systems. The need to redefine the goals of future international ESV conferences after the completion of Research Safety Vehicles (RSV's) development presentations is discussed.

by Kenkichi Konishi
Japan Automobile Manufacturers Assoc., Washington, D.C.
1976; 6p
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 600

SAFE AND FREE 0VEHICLE RESTRAINT SYSTEM FOR REAR OCCUPANTS0

An alternative to the seat belt as a vehicle restraint system to be used by rear occupants is presented by Peugeot. The restraint system takes into account the occupation rate of seats, the nature of the occupants, and the severity level of injuries to the rear occupants in accidents. The proposed system, as designed to protect young children, consists of two parts: the seat itself, attached to the seat belt anchorage points, and the receptacle located in front of the child, who is thus restrained by a large surface padded with a honeycombed material distributing deceleration forces on the whole torso. The plastic rigidity of the belt is replaced by energy absorbing devices connecting the receptacle to the seat while limiting forces applied to the torso. The receptacle is so designed that the occupant's trajectory avoids, in fact, any impact to the head. Adapting this system to adults, the restraint system is attached to the center pillars: it consists of a set of tubes at the torso level (that is the receptacle) and at the lower members level. When an impact occurs the occupant follows on its

the occupant is dissipated through flexion and distortion of the tubes, their rigidity being calculated to maintain the torso deceleration under 60g. The risk of submarining is eliminated by means of additional tubes located at the level of the legs. The advantage of the system is that it affords protection for any location of front seats and for every occupant size from six-year-old children. Results of impact testing of this system, the receptable being placed in a passenger compartment mounted on a test sled using dummies and with impact velocities of about 50 k/h, are presented in tabular form.

by Jean C. Derampe
Centre d'Etudes de Paris des Automobiles Peugeot, BP16, 92250 La Garenne, France
1976; 14p
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 601

THE USE OF COST EFFECTIVENESS AND COST BENEFIT STUDIES FOR THE SELECTION OF VEHICLE SAFETY MEASURES

The basis on which several European governments, members of the European Experimental Vehicles Committee (EEVC), prepare their estimations of the relative costs, benefits, and effectiveness of vehicle safety measures is presented. The theoretical procedures adopted for cost benefit and cost effectiveness calculations are discussed in some detail, and a nine step algorithm is given as an aid for using these methods. A major objective of this report is to show to what extent different conclusions reached by different groups studying the same vehicle safety features were due to differences in basic cost benefit or cost effectiveness procedures, or to different economic and other assumptions, or to differences in costs or in accident situations; and a detailed discussion of these economic assumptions is presented, including a worked example for the evaluation of head restraints in West Germany and the U.K. This example shows in numerical form how very different results can be obtained and the extent to which these arise from the various courses already discussed. It seems likely that teams will produce relative rankings for a series of safety measures which may not differ greatly, though the absolute levels may well be very different. There is a need to check the sensitivity of findings to small changes in assumptions. The benefits of safety measures are far from independent of each other. The context of these procedures should be used as an aid to decision making. A bibliography is included of research papers giving fuller details of the various aspects of this subject. Tabulated data include discount rates used in government studies and discount features for France, Germany, and the U.K.; average age of cars scrapped in 1972 in France, Germany, Italy, the Netherlands, Sweden, and the U.K.; car occupant casualties in 1973 in France, Germany, Great Britain, Italy, the Netherlands, and Sweden; average costs per accident in France, Germany, the Netherlands, Sweden, and the U.K.; average costs in Sweden (1972) and in France and the U.K. (1973) in different currencies; average

European Experimental Vehicles Com.
1976; 35p 24refs
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 602

A NEW APPROACH TO VEHICLE DYNAMIC ANALYSIS OF SEVERE STEERING AND BRAKING INPUTS

Two procedures for evaluating vehicle behavior prior to an upset due to friction between tire and road surface are the closed-loop method in which a machine is substituted for the driver in the vehicle, and the open-loop method with drivers in the test vehicles. Both methods provide information on steering, braking, and accelerating, but the open-loop provides for a systematic investigation of vehicle reactions to reproducible operating functions derived from the closed-loop tests. Complementary use of open-loop and closed-loop evaluations reasonably permits the systematic examination of the behavior of vehicles under realistic conditions. Three upset-related driving maneuvers were chosen for testing: severe lane change with sinusoidal steering input; sinusoidal steering input during cornering at a given lateral acceleration; and drastic steering and braking input. In the closed-loop tests vehicles were used of various types, in standard condition, equipped with outriggers, and driven by test engineers. In the open-loop tests a programmable driving machine developed by Volkswagenwerk AG was used to replace the driver in the following circumstances: when driver influence, input perception or behavior are eliminated or unnecessary to evaluate vehicle performance; when good test reproducibility cannot be achieved for formulated test purposes; and when driver safety can be compromised. The machine must drive (accelerate), steer, and brake through remote control; its weight must not exceed the weight of driver plus seat; it must be of a size and design to be exchanged easily between vehicles; and it must maintain a constant vehicle velocity during dynamics tests. No upsets resulted from maneuvers conducted in the open-loop tests. In the closed-loop tests, upsets resulted during the severe lane change maneuver and in the drastic steering and braking maneuver. In the future, relevant test parameters to quantify both methods will be developed from actual accident cause investigation of steering and braking maneuvers and driver behavior.

by R. Weissner; U. Seiffert
Volkswagenwerk A.G., Res. and Devel., Germany
1976; 23p 2refs
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

ture drivers during daytime driving on a freeway route. Three drivers from each category were selected. Vehicle mirror systems included left side and inside mirrors, and one car equipped with a right side convex mirror. A closed circuit television system consisting of three television cameras, special effects electronics, and electronic counter, a video monitor and a video tape recorder were installed in the rear passenger compartment of the test car. During each data collection run, the subject driver acquired information when traveling straight ahead, and when merging into the lane and making left and right lane changes. Tests involved mirror glance durations for all mirrors and direct looks in each mirror, and combinations of both. Results show that the driver likes to look in the direction that he wants to move the car; that increasing the size of the mirror does not necessarily reduce the information gathering time although he is obviously getting more information because of the larger field of view. The experienced and mature drivers have more efficient vision information gathering patterns and use their mirrors, whereas the novice driver uses the mirrors for maneuvers but does not depend strictly on the mirrors for making decisions. Finally, it appears that the convex mirror can be used for making lane changing and merging decisions by mature drivers and with some additional driving experience by experienced drivers; and further, it appears to improve the vision information gathering process of those drivers who are utilizing them.

by R. J. Donohue
General Motors, Environmental Activities Staff
1976; 17p 4refs
Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.
Availability: Corporate author

HS-019 604

EVALUATION OF THE MICHIGAN TRIAL SUBSTITUTE VEHICLE INSPECTION PROGRAM. FIRST YEAR INTERIM REPORT. EXECUTIVE SUMMARY

by Jairus D. Flora; Richard F. Corn; Ronald L. Copp
University of Michigan, Highway Safety Res. Inst., Ann Arbor, Mich. 48109
Contract MVI-75-001A
Rept. No. UM-HSRI-76-9-1; 1976; 17p
For abstract, see HS-019 605. Rept. for May 1975-Apr 1976.
Availability: Corporate author

HS-019 605

EVALUATION OF THE MICHIGAN TRIAL SUBSTITUTE VEHICLE INSPECTION PROGRAM. FIRST YEAR INTERIM REPORT

In a two-year study, a checklane vehicle inspection program is being evaluated as a substitute for a periodic motor vehicle inspection program (PMV). The first year's effort measured the percent of defective vehicles in two sampled counties and pro- driving population; the most frequent defects; a comparison of the two different methods for testing the braking ability of vehicles (the pull-stop method and the wheel-pull method); any change in defect rate if the percent of inspected vehicles were raised to 15% and coupled with a public information campaign; and a comparison of defect rates between the same set of vehicles tested twice in two years under a 15% inspection program. The two counties selected have a similar number of registered vehicles and each experienced approximately a 15% inspection rate during 1975. The overall passing rate was 52.4% for both counties, compared with a passing rate ranging between 45% and 75% in areas with annual PMVI. Vehicles were tested for defects relating to vision, lighting, exhaust, control, horn, and valid registration. Defect rates were found to increase with the age of the vehicle, but failure rates are mixed when broken down by components. Horns, steering, mirrors, and vision-impaired windshields show little if any defect increase with age; whereas, brakes, windshield washers and wipers, tires, lights, and exhaust show marked increased defects with age. A moving/stopping test for braking capability was compared with a mechanic's inspection of the brakes. If failure by either type of inspection is considered to constitute deficient braking capability, then it is estimated that 6% of vehicles passed by the moving/stopping test have deficient stopping capability, while 22% passed by the wheel-pull inspection have deficient stopping capability. Driver interviews were conducted from those stopped for wheel-pull inspection to represent local traffic rather than long trip and interstate traffic. Drivers in the county which had experienced a more intensive media campaign demonstrated a greater knowledge of the vehicle inspection program than the other county drivers. Further, in both counties, over two-thirds of the drivers agreed that "seat belts save lives" though it was observed that only 11% of the drivers were actually wearing them. A large proportion of drivers in both counties agreed that the 55 mph speed limit reduced traffic fatalities, and a large percentage agreed that higher limits should not be reinstated on state highways or interstates. All drivers whose vehicles were inspected in the random checklane program in 1975 were given a windshield sticker and told that their vehicles were not subject to reinspection for a year, but would be subject to reinspection beginning in the summer (starting in May) of 1976.

by Jairus D. Flora; Richard F. Corn; Ronald L. Copp
University of Michigan, Highway Safety Res. Inst., Ann Arbor, Mich. 48109
Contract MVI-75-001A
Rept. No. UM-HSRI-76-9-2; 1976; 140p 4refs
For summary, see HS-019 604. Rept. for May 1975-Aug 1976.
Availability: Corporate author

HS-019 606

DEVELOPMENT OF A TEST FOR IMPACT PROTECTION. PHASE 1. FINAL REPORT

An Impact Test Apparatus was designed and testing procedures have been proposed to systematically measure the ability of flexible, semi-rigid, and rigid impact protection systems to absorb kinetic energy and to distribute peak impact

to be covered by an impact test apparatus, to establish human tolerance levels for impact, and to collect data on the mechanical properties of the human body. Such data include characteristic mass, equivalent modules of elasticity, and equivalent damping coefficient. Two impact parameters were selected: the kinetic energy that either the falling victim or the flying object could have at the instant of impact, and the momentum of impact. The impact test apparatus consists, functionally, of three parts: the impactor, consisting of a compressed gas source, a pneumatic cylinder, impacting sled, and control valves; the padding system support; and the instrumentation, consisting of three types of sensors, accelerometers, force transducers, and pressure transducers. An impact modeling analysis was performed and the solution obtained permits the assessment of the effects of viscoelastic ground properties and impact parameters on energy absorption, through parameter variation. Modeling parameters and procedures for experimental impact data evaluation have been derived from the analysis. A multitude of impact modes on practically all parts of the human body, skull, torso, leg, and arm, have been included in impact simulations. The proposed impact test apparatus is considered to be a versatile research tool but is, as yet, too complex for routine quality control testing of all of the many impact protection systems currently used and possibly developed in the future. It is recommended that, after completion of the construction of the apparatus, the research be performed which is necessary to describe the mitigation of impact in specific situations. Also, the various combinations of material used in specific protection systems should be evaluated to produce the simplest possible systems and test procedures. Padding systems require more research both through analytical techniques in conjunction with modeling analysis and through experimental research using the impact test apparatus.

by J. M. Akridge; W. D. Freeston, Jr.; M. K. Rao; W. L. Leverett, Jr.; W. D. McLeod; Wolfgang Wulff
Georgia Inst. of Tech., School of Mechanical Engineering, Atlanta, Ga. 30332
Contract NBS-3-35762
Rept. No. COM-74-10983; NBS-GCR-74-24 ; 1973; 80p 70refs
Availability: NTIS $7.00

HS-019 607

TRANSPORTATION ENERGY CONSERVATION DATA BOOK. 1ST ED.

An overview of transportation information includes statistical review of environmental impacts for automobiles, trucks, buses, motorcycles, aircraft, ships, rail, and pipelines generally starting with 1960 and through 1973 or 1974. Additional details for highway vehicles include motor vehicle registration projections, highway vehicle accident and fatality rates, and truck use information. Statistics on energy consumption and the intensiveness of energy use emphasize petroleum consumption, e.g. total per capita energy use in the U.S. decreased between 1974 and 1975 slightly more than 2%, and transportation comprises over half of the petroleum use by the U.S. with the auto accounting for over half of that share. Data show intensity of energy use by various modes of transportation and miles travelled per gallon of equivalent fuel. Average tion demands, greater technical improvements, and large shifts to less energy-intensive modes. The three major areas o government impact in transportation are taxes and expendi tures; regulations; and government research, development, an demonstration programs. Sources of revenue are detailed. Out lays for direct energy research and development of the Energ Research and Development Agency are planned to doubl between the fiscal years 1975 and 1977. Petroleum supply stu dies show the increasing role played by crude petroleum im ports; illustrate U.S. and world petroleum production, imports prices for domestic crude oil and both domestic and foreig gasoline; and project U.S. production capacity to either 199 or 2025, depending on the estimate chosen. Population charac teristics include the key determinant of population of drivin age, and economic determinants to provide a focus on th level and type of transportation services demanded. There an interrelationship between transportation activity and othe economic activities, emphasizing the mutual dependence o one on the other. Bibliographies are included with eac chapter.

by A. S. Loebl; D. J. Bjornstad; D. F. Burch; E. B. Howard; J. F. Hull; D. G. Madewell; N. S. Malthouse; M. C. Ogle
Oak Ridge National Lab., Energy Div., Oak Ridge, Tenn. 37830
Contract W-7405-eng-26
Rept. No. ORNL-5198 ; 1976; 287p refs
Availability: NTIS, printed copy $9.75; microfiche $2.25

HS-019 608

DESIGNING SAFER SEATS

After almost a decade of research and development of the pas sive concept, growing consensus among safety researchers i redirected toward active restraint systems due to the short comings of passive systems such as air bags. Emphasis on ac tive restraints has generated a heightened interest in seat colli sion performance. The cantilever structure of a conventiona seat creates an engineering dilemma since as the seat' strength increases through added structure, the inertial forc of the structure itself can become destructive. A form of roo anchorage has been suggested to resolve this problem. Heac restraints have been found effective in reducing secondary im pact injuries in rear collisions, if properly placed in thei highest position. Belts of pre-stressed design, attached directl to the seat, have been suggested as a means of improving rid down of the occupant's inertia and protection from secondar impacts with the vehicle interior. Submarining, which shift the belt upward across the occupant's viscera, is dangerous i a backrest is in the full-reclined position, so researchers hav added another pair of straps attached to the seat front an fastened into a lap belt connector. A contoured seat attache through structural members to the vehicle side has been sug gested to mitigate delayed, abrupt occupant response to sid impacts. A Volvo production bucket seat has been redesigne by researchers at Severy, Inc., into one which they feel offer adequate occupant protection and whose safety design is fel to be within current state of the art for auto seat production Among its modifications are: a high-section-modulus tubula steel backrest, designed to improve strength both for rear col lision and rollover space; double seat tracks for more positive

anchorages. In laboratory testing, this modified seat showed substantial improvement over production seats, the roof anchorages particularly brought about a dramatic increase in backrest strength with little added weight. It is felt that crucial safety elements of seat design would appear to be easily incorporated into existing seating packages.

Publ: Automotive Engineering v84 n10 p37-40, 78 (Oct 1976)
1976
Based on SAE-760810 "Automotive Seat Design and Collision Performance," by D. M. Severy, D. M. Blaisdell, and J. F. Kerkhoff. Presented at the 20th Stapp Car Crash Conference.
Availability: See publication

HS-019 609

CATALYTIC CONVERTER TEMPERATURES TESTED

Tests were conducted which concentrated on measurement of 1974 and 1975 passenger vehicle exhaust system surface temperatures and their comparison with earlier models to evaluate the possible dangers of high exhaust temperatures of catalytic converter equipped vehicles. The test fleet consisted of 37 vehicles not representative of the national 1974-75 vehicle population due to program urgency and limited availability; no thermal reactor vehicles and few foreign cars were evaluated. The 1975 models were California vehicles and as such had emission control systems different from the other state vehicles. Road tests were conducted on the seven mile, 4% grade, Mt. Baldy test course, and test runs were made in drive gear at 40mph or maximum speed if 40mph could not be maintained. Exhaust temperature cool down rates were monitored while vehicles idled after driving the course. Several modes of dynamometer tests were studied for each vehicle and various engine malfunctions were induced in some of them to evaluate malfunction effects on exhaust system temperatures. Exhaust systems were instrumented at several locations with Chromel-Alumel thermocouples, and multipoint recorders with a 0-2000° F range were run at a 1/2 ipm chart speed; peak and equilibrium temperatures were read directly from these charts. Catalytic converter equipped cars present essentially the same hazards as older cars not so equipped when the engine is operating properly. The hottest point on the exhaust system of nonconverter vehicles is the first bend, while the converter outlet is the hottest point on converter equipped vehicles. A large portion of the exhaust systems of both converter and nonconverter cars, under severe operating conditions, is likely to be at temperatures in excess of that necessary to ignite ground cover fuel in a relatively short contact time. Maximum exhaust system temperatures are obtained for both converter and nonconverter vehicles during high flow, high load operation. Coasting and cruise modes do not lead to excessively high exhaust system temperatures even with one or more spark plugs misfiring on converter equipped vehicles. Ignition system failures can be expected to increase exhaust system temperatures significantly in converter equipped vehicles. Exhaust gas from both converter and nonconverter vehicles is cooled to a safe temperature by mixing with air within one inch of the exhaust system exit. A real danger may exist for occupants of certain converter equipped vehicles when the en-

Tests," by Robin T. Harrison. Presented at the Automobile Engineering Meeting, Dearborn, 11-15 Oct.
Availability: See publication

HS-019 610

DESIGN FOR CRASH SURVIVAL OF AUTOMOBILE OCCUPANTS

Five articles concerning crashworthiness and automotive design deal with the following subjects: statistics of crash injury causation; biomechanics as a tool for quantifying data; the crashworthiness of the Pinto and other subcompact cars; evaluating field performance of highway median barriers; and possible crash-attenuation devices of the future.

by Joan B. Silberman, ed.
Rept. No. TRR-586; 1976; 66p refs
Includes HS-019 611–HS-019 615. Prepared for the 54th Annual Meeting of the Transportation Research Board.
Availability: TRB $2.60

HS-019 611

THE CRASH ENVIRONMENT

Crash environment studies dealing with specific accident circumstances are based on police reports summarized by the National Safety Council and on in-depth data from the Calspan trilevel program, including multidisciplinary team investigations. Data concern the following: severity of injury according to police rating and the abbreviated injury scale (AIS) indexes; accident type, i.e., pedestrian, two-vehicle collision (angle, head-on, rear-end, or other), single-vehicle collision, noncollision; extent of damage according to the vehicle deformation index (VDI); occupant seat position, use of restraints and whether ejected. Level two accidents (8,145 police investigated accidents involving a recent model vehicle) and level three accidents (358 such accidents requiring hospital treatment for at least one occupant) are considered. National Safety Council data indicate that two-vehicle accidents are more frequent and result in more fatal accidents than other types of accidents. The single-vehicle noncollision accident ranks second in occurrence, but the proportion resulting in fatal injury is higher than in two-vehicle accidents. Police ratings of injuries cannot discriminate among injury levels and appear to be adequate only to identify the occurrence of injury or fatality. Accidents classified as level three involved more single-car than two-car accidents; more impacts from the front and fewer from the rear; more impacts to the front, top, and undercarriage and fewer to the rear; more right front occupants and fewer drivers; about five times more occupant ejection than in level two accidents; less use of restraints; and twice as many drinking drivers, ill drivers, or drivers who had fallen asleep. Two-car accidents involving severe or worse injuries involved more impacts to the left front area than single-car accidents, larger impact areas, more rear impacts, and

1976; 5refs
Prepared for the 54th Annual Meeting of the Transportation Research Board.
Availability: In HS-019 610

HS-019 612

HUMAN INJURY MECHANISMS AND IMPACT TOLERANCE

The complex subject of human injury mechanisms and impact tolerances in automobile accidents is reviewed; injury patterns are described; and the status of knowledge in the biomechanics of trauma of the head, neck, chest, abdomen, and extremities is discussed. Lack of documentation, complicated human structures, difficulty in evaluating injury, inadequate instrumentation, and imperfect animal models make research difficult. Head and chest injuries are the most critical followed by injuries to the abdomen and extremities. The head and neck are the most frequent injuries, but are not of a critical nature as often as thoracic injury, particularly rupture of the thoracic aorta. Head injuries may be produced by direct impact that involves short durations and high acceleration or by inertial loading with large angular motions and longer time periods. In the neck, some low-velocity impacts can produce injury as severe or more severe than high-velocity impacts. Abdominal tolerance to injury is low. While seat belts and shoulder harness have helped to prevent injury to the head and upper torso, lap belt related abdominal trauma causes concern because it is hard to diagnose and there is a serious threat of hemorrhage and infection. To prevent abdominal injury, safety belts must remain below the iliac crest and the pelvis should bear all the load. Injury to the extremities is frequent but not life-threatening, and the elimination of rigid edges in the car interior would reduce injury. Appropriate levels for tolerable impact forces, accelerations, and deflections have not yet been established; and until such time as research provides more definitive information, the car designer will have to rely on conservative estimates and values. Energy-absorbing restraint systems, collapsible steering columns, improved windshields, and redesign of car interiors and dashboards are necessary to avoid head impact and to reduce the angular and linear accelerations of the head, and to minimize injury to other parts of the body. Seat belts must be designed to make it impossible for the wearer to keep them loose or twisted, and to make them comfortable so that they will be worn.

by John W. Melvin; Dinesh Mohan; Richard L. Stalnaker
University of Michigan, Highway Safety Res. Inst.
Publ: HS-019 610 (TRR-586), "Design for Crash Survival of Automobile Occupants," Washington, D.C., 1976 p11-22
1976; 47refs
Prepared for the 54th Annual Meeting of the Transportation Research Board.
Availability: In HS-019 610

modifications were made and tested on 1974 Pintos. Since the most common and costly accident mode is frontal offset and angular impact, emphasis was placed on this type. Modifications to the Pintos consisted of replacing the sheet metal with bulk structure, i.e., foam-filled (stabilized) sheet metal, and altering the passenger compartment configuration. Front and side modifications resulted in a net increase in weight of 39 lbs over the baseline car at a cost of between $200 and $400. The consumer cost of passive restraints resulted in a net increase of 39.9 lb and a cost range of between $50 and $200. The effective safe barrier equivalent velocity of the modified vehicle in conjunction with an advanced airbag restraint was found to be approximately 50 mph (80 km/h) in head-on and angled-barrier crashes and in two-car angular and offset collisions. The results of the study has been to establish provisionally the prototype feasibility of meeting the proposed 1979 Federal Motor Vehicle Safety Standard (FMVSS) 208 amendments requiring 45 to 50 mph (72 to 80 km/h) barrier equivalent velocity frontal crash protection with a subcompact car.

by D. Friedman; R. Tanner
Minicars, Inc., Goleta, Calif.
Publ: HS-019 610 (TRR-586), "Design for Crash Survival of Automobile Occupants," Washington, D.C., 1976 p23-31
1976; 14refs
Prepared for the 54th Annual Meeting of the Transportation Research Board.
Availability: In HS-019 610

HS-019 614

IMPACT PERFORMANCE AND AN EVALUATION CRITERION FOR MEDIAN BARRIERS

This study involves the determination of the impact performance of the Texas metal beam guard fence (MBGF) median barrier and a comparison of its performance with that of the Texas concrete median barrier (CMB), the two basic median barriers used by the Texas State Department of Highways. The MBGF consists of two standard W-shaped guardrails mounted back on back on a support post; the CMB is a solid concrete barrier. The impact performance of the guard fence was determined from a combination of crash tests and from crash simulations by the Highway-Vehicle-Object Simulation Model. Standard-sized automobiles were used in both the crash tests and crash simulations. A close comparison of test and simulated results verified the accuracy of the model in simulating impacts with the metal guard fence. The impact performance of the concrete barrier was obtained from another study. Inspection of 135 median barrier impacts on various urban freeways in Texas was made to determine the distribution of impact angles. These field measurements, supplemented by data from the highway simulation model, provided impact angle probabilities as a function of median widths. It was found that the MBGF will contain and redirect an automobile impacting at 60 mph (97 km/h) at impact angles of 7°, 15°, and 25°, with no tendency for the automobile to become unstable after impact and with an exit angle for the vehicle that is not large. Serious or fatal injuries are not predicted for impacts at angles less than 15° and speeds of less than 60 mph

7° or more. The study provides an evaluation criterion that can be used for objectively comparing the impact severity of the MBGF and the CMB as a function of the median's dimensions, and can be used to determine which type barrier to install.

by Hayes E. Ross, Jr.; John F. Nixon
Texas A and M Univ., Texas Transportation Inst.; Texas State Dept. of Highways and Public Transportation
Publ: HS-019 610 (TRR-586), "Design for Crash Survival of Automobile Occupants," Washington, D.C., 1976 p32-49 1976; 10refs
Prepared for the 54th Annual Meeting of the Transportation Research Board.
Availability: In HS-019 610

HS-019 615

AUTOMOBILE-ATTENUATOR COMPATIBILITY IN 1985: SOME DESIGNER GUIDELINES

Extensive analysis of automobile accident data from the designer's point of view reveals, among other things, the importance of fixed-object collisions in automobile societal losses. Collisions with fixed objects wider than 16 inches accounted for 8,500 fatalities and 179,000 disabling injuries during 1971. Moreover, the analysis has yielded information about the distributions of speed and injury in such crashes. The fixed-object collision situation can be described rather completely in terms of societal cost (more than $72 billion in 1971 due to wide fixed-object collisions), and can be extrapolated by assumption to the situation to be expected ten years hence. It is estimated that there will be 140 million vehicles and 125 million passenger cars. There will be a 25% increase in accidents. Smaller and subcompact cars will represent 60% of new cars and 50% of accumulated passenger miles. The average car will exceed 1976 crashworthiness requirements, due to improved passenger restraints (active and passive) and to structural soundness. The analysis makes possible a rough engineering characterization of the optimal highway crash attenuator device (HCAD) for the occupants of tomorrow's family car. The future car's average frontal structure force is estimated to be about 80,000 lbf and the subcompact car's frontal crash pulse as not exceeding 85,000 lbf. Hence, the future HCAD for protection in fixed-object collisions should be designed to have a crush force not to exceed 75,000 lbf and could yield the same general pulse form as the standard car frontal structure. HCAD characteristics in 1985 could have a lower total energy absorption capability and higher force levels than those of today's design. It is estimated that the societal benefit potential of a 60% efficient attenuator deployment would be $528 million/year, if most fixed-object sites, such as piers, pillars, abutments, and large signs were to be provided with attenuators. Whether or not this is cost beneficial depends on the number of attentuators needed and the cost per unit. More detailed economic and engineering analysis is needed, but the rough projections of this report indicate that the future HCAD must be smaller, stiffer, and more cost-effective than the current models. A broader and more effective implementation of cost-effective HCAD's should be planned

Prepared for the 54th Annual Meeting of the Transportation Research Board.
Availability: In HS-019 610

HS-019 616

NON-CONTACT DIAGNOSIS OF INTERNAL COMBUSTION ENGINE FAULTS THROUGH REMOTE SENSING

A method has been developed for obtaining engine speed and diagnostic information for a diesel engine without mechanical or electrical connections to the engine. The original work was done on a six cylinder, four cycle, naturally aspirated, military LD465 diesel engine manufactured by Teledyne/Continental. This noncontact technique has the potential for making diesel engine power measurement and fault detection extremely simple and rapid. The method employs a single transducer held in the exhaust, air inlet or oil filter and special purpose circuitry which extracts the engine speed information from the signal and performs spectral analysis for diagnostic purposes. Circuit outputs are engine speed, a digital pulse train with repetition rate proportional to engine speed, and a harmonic ratio which sensitively indicates the degree of nonuniformity among engine cylinders. Diesel engines with minor compression losses or fuel injection faults can be identified readily without vehicle contact in less than one minute of testing. With additional signal processing, the power producing capability of the engine can also rapidly be evaluated.

by S. C. Hadden; L. R. Hulls; E. M. Sutphin
RCA Corp., Government and Commercial Systems Div.
Rept. No. SAE-760146; 1976; 11p 7refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 617

NEW SOLID STATE MAGNETO IGNITION AND LIGHTING CONTROLS FOR RECREATIONAL VEHICLES

Because recreational vehicles may be used only occasionally and prolonged intervals of nonuse may result in deterioration of the ignition system, new solid state magneto ignitions and lighting controls were developed which provide certain add-on, superior functioning parts where standard internal combustion engines are utilized as the power plant. Solid state ignition systems need no tune-ups, resist deterioration, and are immune to environmental contamination. A single solid state system was produced to satisfy the ignition spark needs of many different makes and models of engines, contained in one package to be mounted on a single pole of the stator lamination stack, and consisting of a single pole small coil assembly. Problems were overcome in avoiding any mechanical interferences when mounted on the prescribed engine. Various lighting system controls are illustrated, and one, which is a cir-

cuit of combination regulator and rectifier arrangements, has the advantage that in the event the battery is removed or has a loose terminal connection, the capacitator takes over as the averaging assist in place of the battery so the light system is regulated and protected at all times. Both the ignition system and lighting controls can be installed by the owner without the need for any special tools.

by T. Frazer Carmichael
Syncro Corp.
Rept. No. SAE-760148; 1976; 7p 2refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 618

THE FOURIER TRANSFORM APPLIED TO VEHICLE EXTERIOR NOISE SOURCE IDENTIFICATION

A motor vehicle noise source identification technique designed for use during a drive-by test provides, by application of the Fourier Transform, the capability to obtain a narrowband (9.8 Hz) frequency resolution over an extended frequency range (0-10,000 Hz) at the peak vehicle noise level, a particular RPM, or a particular vehicle location in the test zone. Other features include corrections for the Doppler shift, averaging of noise tests, and subtraction of spectra of two separate noise tests from a component disconnect/reconnect procedure. The above analysis, in conjunction with the noise source isolation resulting directly from the disconnect procedure, identifies the major vehicle noise contributors in terms of their respective amplitudes and frequencies. Application of this technique to several vehicles has demonstrated its ability to accurately identify the dB(A) levels and problem frequencies of the major vehicle noise contributors in the vehicle environment.

by V. A. Daniels; R. E. Veres
Ford Motor Co.
Rept. No. SAE-760151; 1976; 11p
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 619

A TIRE NOISE INVESTIGATION AND TEST METHOD

Exterior tire noise was investigated to determine present passenger car tire noise levels and to develop a passenger car tire noise test. The procedure took into account the importance of conducting tire noise tests on a standardized road surface texture. Fourteen sets of tires, consisting of thirteen 1975 experimental and production constructions and one ASTM skid test tire were used. Testing consisted of coasting at various speeds on three different road surfaces past microphones which were located at 25 and 50 ft from the vehicle centerline at ground level and 4 ft height. Testing occurred under a wide variety of environmental conditions. Road surface macrotexture change (Portland cement, epoxy paint, and asphalt) exhibited greater noise variation than the difference between the 11 tire constructions, which included one snow tire, tested on the same surface. A quantitative method of defining road surface texture which can be used to predict the noise level of a given tire on another texture is an essential requirement to any type of meaningful tire noise legislation. Two possible primary direct texture measuring techniques for predicting passby noise are the Schonfeld stereophotographs and the road profile traces. Load variation from light (driver only) to maximum design load showed only small changes of up to 1 dBA for a particualr car. Tire wear may be a factor for the first 200 miles. After this break-in period, variation up to the tested 1000 mi is minor. Tire velocity has a major effect on tire noise; a 2 mph variation can result in up to 1 dBA change at medium speed. Tire noise contribution can be a significant factor as it contributes to the overall vehicle noise level, because in 1979 Florida and Oregon will require drive-by noise laws of 75 dBA maximum. Regarding microphone height, the ground height does not exhibit any distinct advantage over the standard four foot height for tire noise measurement purposes. Regarding microphone distances, it is recommended that tire noise measurements below 50 mph be made at 25 ft and above 50 mph at 500 ft. In summary, surface and speed has to be controlled precisely for repeatable results. In spite of the wide variety of tires, the tire noise variance averaged only 2.5 dBA. This indicates that noise reductions beyond 2 dBA for passenger car tires will be very difficult to achieve with changes in the tread design.

by R. E. Veres
Ford Motor Co.
Rept. No. SAE-760152; 1976; 23p 13refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 620

TIRE ROLLING RESISTANCE MEASUREMENTS FROM COAST-DOWN TESTS

Coast-down tests of road vehicles, when properly carried out, will relate laboratory-measured tire rolling resistance, obtained from the rotating drum technique, to the rolling resistance that exists under actual operating conditions. Data reduction must include all test conditions, including vehicle mass, roadway grades, and wind velocities; and the characteristics of the mechanical rolling resistances (including the tires) must be known as a function of velocity or the aerodynamic drag coefficient. The aerodynamic drag coefficient must be obtained by using the calibrated variation of tire rolling resistance, from the results of the rolling drum techniques, with speed. When this coefficient is determined, then comparative rolling resistances of a number of tire sets can be accurately determined under real-life operating conditions. Rolling resistances under actual operating conditions of the various tires can be inferred to a reasonable degree of accuracy by applying the differences of calibrated rolling resistances from drum calibrations to that determined during the coast-down tests. By applying these relative determinations, it is possible to generate a comparison of the rolling resistances of the radial vs the bias tires (both with new tread) under the conditions of the coast-down tests. Such a calculation gives the expected result that the rolling resistance of the radial tires was about 20-25% less than that of the bias tires. A test procedure is described as developed by the U.S. Dept. of Transportation to measure the aerodynamic drag of a typical automobile under actual operating conditions. The vehicle was accelerated successively to various velocities on a near-level roadway and allowed to coast through an instrumented section of roadway while the required time-distance data were recorded. These data, in conjunction with other information about the vehicle, the roadway and the atmospheric conditions, were then processed in the

Availability: SAE

HS-019 621

ENGINE CYCLE SIMULATIONS AND COMPARISONS TO REAL ENGINE PERFORMANCE

An analytical framework is assembled, suitable for the quantitative evaluation of engine performance (fuel consumption, WOT, NOx 0oxides of nitrogen0, emissions) and the appreciation of engine performance sensitivities and trade-offs. Emphasis is placed on complete, conventional spark-ignition engines in production. The framework is assembled primarily from existing and well documented analyses that deal effectively with various specific aspects of the internal combustion engine. A new and nonconventional approach is followed in the treatment of engine breathing dynamics. The engine-manifold system is treated and documented as a sequence of many small but finite control volumes, each obeying individually the field form of conservation equations. The qualifications of the analytical framework are evaluated by an extensive comparison of analytical results to dynamometer test results of engines with fairly well known design and control parameters, which are also presented. Results of two production (one 8-cylinder and one 4-cylinder) engines are used over a wide range of loads and speeds. Extensive comparisons are illustrated of BMEP, BSFC, BSNOX and WOT air flow. Agreement ranging from good to fair is observed depending on operating conditions, with the comparisons becoming poorer at very low loads and high EGR rates. Various factors limiting the resolution of applications include substantial uncertainties in such input as combustion initiation and duration. Also, there may be uncertainties in estimation of residual traction in the cylinder as a function of engine design control, and operating parameters.

by A. C. Malliaris; T. Trella; H. Gould
Department of Transportation
Rept. No. SAE-760155; 1976; 20p 21refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 622

A TECHNIQUE FOR OBTAINING AN ENGINE EMISSIONS MODEL BASED ON CONTINUOUS EPA--CVS (ENVIRONMENTAL PROTECTION AGENCY--CRANKCASE VENTILATING SYSTEM) TEST DATA AND A DYNAMIC VEHICLE MODEL

A new technique for obtaining engine emission flow rate maps has been developed. The maps are based on specific emissions data obtained on a continuous basis over a single EPA-CVS urban driving cycle test. The basic set of data used for the emissions modeling was obtained from a 1973 model 4800 lb. vehicle with a 400 CID engine. Emission flow rates and engine temperatures (as measured at the exhaust valves as well as the exhaust manifold) were recorded continuously over an EPA-over any type of driving cycle. The data are averaged [illegible] various torque-speed ranges of the engine. It has been found that these dynamic average emission flow rate maps, which are functions only of engine torque and speed, allow instantaneous emissions to be fairly accurately predicted, and are less costly and time consuming than the traditional steady state method. It also appears that the technique might be used advantageously to determine engine calibration parameters. These conclusions must be tentative since the work is based on OPA-CVS and steady state engine data for a single vehicle.

by Richard Radtke; Andrew Frank; Norman Beachley
University of Wisconsin at Madison
Rept. No. SAE-760156; 1976; 14p 4refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 623

SIMULATED SENSITIVITIES OF AUTO FUEL ECONOMY, PERFORMANCE AND EMISSIONS

The applicability of the simulation approach is examined by extensive comparisons with integrated vehicle test results. The subject is treated on the basis of detailed engineering test data regarding components and parameters of 1975 autos. The inputs include engine performance maps obtained from dynamometer tests of 1975 production engines, covering the complete range of engine loads and speeds. These maps refer to specific fuel consumption, not performance and emissions. Also included in the input are torque converter and other drive train characteristics such as gear and rear axle ratios and losses, shift logics, rotating inertias, and tire parameters and accessory loads provided by manufacturer specifications. Vehicle inertia weight, and road load are input as prescribed by EPA (Environmental Protection Agency) test procedures. Twenty-two different cases are treated in order to cover a fairly wide cross-section of the U.S. auto fleet. It is found that fuel economy for the EPA driving schedules is adequately simulated with a 5% to 10% uncertainty, about the same as is encountered in performance simulations. Larger uncertainties are evident in the simulation of emissions. Oxides of nitrogen (NOx) prediction has an uncertainty of up to 25% but no significant bias, while carbon monoxide (CO) and hydrocarbons (HC) are very substantially over-predicted and under-predicted respectively. Excepting HC and CO, several applications are made in the evaluation of sensitivities to various auto components and parameters. Evaluations are made of changes in auto weight, engine displacement and rear axle ratio, considered individually and in combinations. Drivetrain changes are also evaluated for three speed automatic transmissions which provide fuel economy benefits ranging from a few percent to over 15%. These changes include individually or in

Availability: SAE

HS-019 624

POWERTRAIN SIMULATION: A TOOL FOR THE DESIGN AND EVALUATION OF ENGINE CONTROL STRATEGIES IN VEHICLES

A powertrain simulation model is developed which translates the demands of a vehicle driving schedule into engine RPM/torque versus time trajectory for an automatic transmission vehicle in any given driving cycle. The formulation of a time density matrix in the speed/load plane of the engine allows a rational approach to the selection of dynamometer test points for emission control strategy development, fuel economy improvement and/or component development and evaluation. Steady-state engine dynamometer data combined with the results of the powertrain model can be used to project emissions and fuel economy values for an entire drive cycle such as CVS-Hot. This provides the development engineer with a powerful tool to make preliminary assessments of the potential of various control strategies or intended component modifications without the necessity of building a complete vehicle prototype. It also provides the basic building block for optimizing emission control strategy to meet required constraints with maximum fuel economy. Limited comparisons between actual vehicle tests and powertrain projections show good agreement in trends.

by Paul N. Blumberg
Ford Motor Co., Res. Staff
Rept. No. SAE-760158; 1976; 22p 6refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 625

EFFECTS OF ENGINE VARIABLES ON TURBULENCE IN A SPARK-IGNITION ENGINE

Measurements of turbulence within the cylinder of a motored Waukesha CFR engine were taken with a hot-wire anemometer which measures heat transfer rate. Tests were conducted over a wide range of engine speeds, volumetric efficiencies, and compression ratios with both shrouded and nonshrouded intake valves. Data were processed digitally using both ensemble-averaging and time-averaging techniques. Mean velocities, turbulent intensities, and turbulent micro and integral scales were computed. A nonstationary, time-averaged analysis was found to give consistent and physically reasonable results, as the nonstationary definition of engine turbulence includes mean velocity variations. The in-cylinder turbulence which exists near TDC of compression is isotropic, with its intensity and scale linear function of intake volume flow rate deter-

HS-019 626

EFFECTS OF TURBULENCE ON SPARK-IGNITI ENGINE COMBUSTION

Tests of effects on mixture turbulence on combustion spark-ignition (SI) engine were made using a CFR engine ratio of turbulent to laminar flame speeds (FSR) is used late the effects of turbulence on flame propagation from mal effects. The apparent instantaneous turbulent flame during combustion was calculated from a combustion release model that used measured cylinder pressures a sumed spherical flame propagation. This flame speed wa related with turbulent intensities measured in the motore gine. The ratio of fully developed turbulent flame spe laminar flame speed was found to be a linear function o tered turbulent intensity. There is no indication that turb scale affects this correlation. A quantitative relationshi pears to exist between the FSR during flame developme the turbulent energy spectrum, but both the physical va of and approach to this relationship remain unproven. A dix A describes the single cylinder Waukesha CFR engine pendix B gives equations for and thermodynamic propert the combustion model. Appendix C discusses computati laminar flame speeds. Appendix D concerns ignition dela combustion duration. Appendix E gives the derivation o theory for flame development.

by David R. Lancaster; Roger B. Krieger; Spencer C. Sorenson; William L. Hull
General Motors Corp., Res. Labs.; Univ. of Illinois, Mechanical Engineering Dept.
Rept. No. SAE-760160; 1976; 24p 43refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 627

PERFORMANCE AND NOx EMISSIONS MODELI OF A JET IGNITION PRECHAMBER STRATIFIE CHARGE ENGINE

A cycle simulation model for the jet ignition precha stratified charge engine has been developed to predict e indicated efficiency and oxides of nitrogen (NO) emis The following are given for the model: engine geometry, speed, air-fuel ratios, pressures and temperatures in the intakes, flow ratio, and a suitable combustion model. The tive importance of the parameters required to define the bustion model are then determined, and values for ig delay and burn angle are obtained by matching predicte measured pressure-time curves. For a given engine geon variations in auxiliary chamber burn angle and fraction of iliary chamber burned before main chamber combustion menced have little impact on predicted engine efficiency oxides of nitrogen emissions. Also, changes in the ig delay and main chamber burn angle, again for a given e

geometry, as engine parameters are varied, are modest. Predicted and measured NO emissions are in reasonable agreement over a wide range of engine operation. Of total exhaust NO, prechamber NO is the major source for overall air-fuel ratios leaner than 22:1, in the absence of EGR (exhaust gas recycle). Trade-off studies done with combustion model parameters held constant will be useful indicators of engine performance and NO emission trends for fixed engine geometry. Appendix A concerns thermodynamic properties of unburned and burned gases. Appendix B presents an approximate method for calculating air-fuel ratios at spark. Appendix C deals with expansion of energy conservation equations. Appendix D concerns intake manifold pressure estimation.

by S. D. Hires; A. Ekchian; J. B. Heywood; R. J. Tabaczynski; J. C. Wall
Ford Motor Co.; Massachusetts Inst. of Tech.
Rept. No. SAE-760161; 1976; 31p 18refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 628

THE EFFECTS OF FLUID MOTIONS ON COMBUSTION IN A PRECHAMBER BOMB

A two-chamber bomb was used to investigate the effect of fluid motions on combustion characteristics, in particular exhaust emissions. Variations in prechamber volume, connecting orifice geometry, air-fuel charge stratification, and initial turbulence of the charge were examined. Tests were run over a wide air-fuel ratio. High-speed motion pictures were used to study flame propagation and fluid motions, and provide a useful research tool. Results are based on emissions data, pressure-time traces or histories to determine burn time, and viewing of the motion pictures. Alterations of jet strength and/or direction create drastically different flame propagation rates, flame-front motions, and jet agitation. The strength of the turbulent jet, which ignites the main-chamber charge, only slightly affects the oxides of nitrogen emissions over the entire air-fuel ratio range tested. The influence of turbulent-jet strength on hydrocarbons (HC) emissions varies with air-fuel ratio. In the important part of the lean range an increasing jet strength increases HC emissions, but at very lean air-fuel ratios the trend is reversed. Depending on the geometries used and specific operating conditions, flow exchanges between chambers exist and have a significant influence on the state of the fluid motions in each chamber thereby affecting both combustion and heat transfer.

by Edward D. Klomp; Gail R. Deboy
General Motors Corp., Res. Labs.
Rept. No. SAE-760162; 1976; 16p 5refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 629

THE INFLUENCE OF AN IGNITION ACCELERATOR ON THE IGNITION QUALITY AND ANTI-KNOCK PROPERTIES OF LIGHT HYDROCARBONS IN THE DIESEL ENGINE

A modified cetane test method was developed to measure low cetane numbers of commercial gasolines and light hydrocarbons in the diesel engine. The method is based on the standard cetane method and the BASF test commonly used in Germany. The goal is development of a multi-fuel engine. Test fuels were isooctane, benzene, and diisobutylene; variable parameters were olefins, aromatics, and saturates. Both ignition quality or cetane number and knocking characteristics or octane number were tested. The newly defined motor cetane number provides a correction of increased intake air temperatures by the value of the sensitivity of the respective cetane/1-methylnaphthalene mixture. Cetane number increase caused by the ignition improver cyclohexanolnitrate is almost linear; composition of the test fuel was the main influence on cetane number. Quantitative prediction on ignition improver susceptibility of unknown fuels is not possible because of great synergisms and antagonisms observed in mixtures. In the case of octane number decrease caused by the ignition improver cyclohexanolnitrate the standardized "compression ratio for standard knock intensity" must be considered instead of the octane number. The ignition improver susceptibility increases proportionally to the compression ratio corresponding to the clear octane number. The results of research and motor method are very similar. There was found no influence of the fuel composition. The Wilke correlation between octane number and standard cetane number (CN 0 60 - 0.5 ON) was substantiated essentially not only for the motor octane number used by Wilke but also for the research octane number. However this correlation cannot be applied to the motor cetane number. A linear correlation was found between motor octane number and "motor cetane number" with the parameter of ignition improver concentration. High-olefinic fuels of low ignition improver content seem to be the best fuels for diesel-type multi-fuel engines if a high octane number is also required at the same time.

by Klaus Becker
Umweltbundesamt, West Germany
Rept. No. SAE-760163; 1976; 16p 18refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 630

ALUMINUM IN AUTOMOBILES: WHY AND HOW IT'S USED

Today's automobile market demands an economic, fuel-efficient vehicle. Factors affecting fuel economy are vehicle size, weight, engine size, emissions controls, shape and accessories. Vehicle weight is important because it effects road performance, emissions and structural design. The use of aluminum in automobiles is discussed in terms of two Chrysler vehicles: the Feather Duster, a production vehicle, and a prototype called Charger XL. Aluminum can reduce vehicle weight but in using aluminum the initial purchase price of the automobile is likely to increase, since aluminum costs more than steel. The increased purchase price can be offset by decreased operating costs (tire size, taxes and fuel). The role of inertia weight class is important since, if a vehicle is close to dropping into the next lower inertia weight class or going over into the next higher class, aluminum may be the only solution. New technology in design, forming and assembly of aluminum parts is needed to substitute aluminum for more conventional metals. Sheet aluminum can be used in bumper systems, body panels and miscellaneous small parts (disc brake splash shields and catalytic converter heat shields). Aluminum will only be used when there exists a definite economic

and yield strength required to give equivalent dent resistance with steel, together with mathematical formulae used in the calculations.

by R. A. George; W. E. Swenson; D. G. Adams
Chrysler Corp., Materials Engineering
Rept. No. SAE-760164; 1976; 16p 14refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 631

DYNAMIC DENTING OF AUTOBODY PANELS

Dynamic denting properties of aluminum and steel auto body panels were experimentally measured under controlled conditions by Reynolds Research and Development, using panels formed by the Chrysler Corporation. For the experiments an air-operated gun firing a spherical projectile was used and all tests were performed on as-produced plant material. Results indicated that dent resistance was not a simple function of thickness and velocity. It was determined that firing the projectile against panels of different material properties and geometries would provide an insight into the dynamic denting problem. Material, geometric and dynamic factors were graphically and statistically evaluated to determine design equations. For impact velocities of 20-60 mph and sheet gauges of 0.027-0.040", dent depths are shown as linear functions of impact velocity. This linear velocity model incorporates sheet thickness, yield strength, density and modulus of elasticity of the alloy used, as well as the geometric shape of the fabricated panel. As an example, for equal dent resistance, a panel of 2036-T4 aluminum would need to be 10-13% thicker than the same panel fabricated from 0.035" gauge 1010-CQ steel. Mathematical models which incorporate strain rate and panel size and relate dynamic denting with an equation for plastic deformation are not yet developed. The analysis is part of a continuing program to enable selection of the best alloy composition and thermal and mechanical processing for sheet to be used for auto body panels. The experiment's results are shown in tabular and graphical form.

by C. E. Burley; B. A. Niemeier; G. P. Koch
Reynolds Metals Co.
Rept. No. SAE-760165; 1976; 10p 9refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 632

AN IONIZATION PROBE STUDY OF SMALL ENGINE COMBUSTION CHAMBERS

Combustion characteristics of an L-head engine combustion chamber have been examined using spark plugs as ionization probes and Plezotronic pressure transducers. The method of recording pressure rise rates, peak pressures, mean effective pressures, and flame arrival times is given. The flame arrival times were then used to find the position and shape of the

Onan Corp., Onan Div.; Univ. of Minnesota
Rept. No. SAE-760170; 1976; 13p 10refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 633

INTERNATIONAL CUB CADET GARDEN TRACTORS

There are six models in the 1975 line of Cub Cadet tractors, al powered by a single cylinder air-cooled engine ranging in siz from 8 to 16 HP. The new machines were designed to reduc the noise and vibration levels, provide new styling, and im prove safety and reliability. Specific features incorporated int the new machines were an iso-mounted engine and engine en closure to reduce noise and vibration and provide new styling The drive train was modified with flexible coupling to allow for misalignment and engine movement. Additional ducts and baffles were added to provide for adequate cooling of the engine (to allow continuous operation at 100° F. ambient temperature). A larger, quieter muffler was added as well as a ducted air cleaner. The machines were equipped with new electric IPTO clutches so that with the flip of a switch the operator could engage or disengage the implement drive for added safety. Hydrostatic speed controls were designed for better controllability and the instrument panels included hourmeters to help the operator determine when it was time for servicing. Specifications of the new machines are included, together with photographs, engineering drawings and graphs showing noise levels and vibrations of the seat, steering wheel, foot platform and engine at different engine speeds.

by David A. Fulghum
International Harvester Co.
Rept. No. SAE-760171; 1976; 12p
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 634

COMPARISON OF COMPUTER PREDICTIONS AND EXPERIMENTAL TESTS FOR TWO-STROKE ENGINE EXHAUST SYSTEMS

The effect of exhaust system configuration on performance of two-stroke engines is studied by comparing computer predictions of gas dynamic behavior in the exhaust pipes to experimental results of real pipe tests. Predicted pressure, velocity and temperature histories at key points in the exhaust system explain the relative power differences for the test pipes. Predicted volumetric flow rates show the effectiveness of exhausting gases at larger pipe cross sectional areas in reducing noise output. The applications of the computer predictions to a Yamaha RS 100 offers an explanation for the experimentally measured loss of power at mid-range speeds encountered using one of the two test pipes. A relative comparison of the two

systems shows that the differing pipe geometries cause predicted pressure and velocity histories to change. These changes are correlated to actual power curves. An experimental exhaust system is presented for the Yamaha 360 MX which increases power and is quieter than the stock system. For this model, the flat reflector combined with the inside-out stinger improved the power while reducing noise. It seems possible to construct an exhaust system with extensive muffling which will produce the same power as the very loud unmuffled stock system. Computer predictions are used to explain the increased performance.

by Michael Ospring; Dean Karnopp; Donald Margolis
University of California at Davis, Dept. of Mechanical Engineering
Rept. No. SAE-760172; 1976; 16p 11refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 635

PLASTICS IN THE AUTOMOBILE INDUSTRY IN EUROPE

Plastics consumption in automobile production rose impressively until the oil crisis. The rise was a result of improved materials, economy and plastics applications in the safety features of motor vehicles. The oil crisis triggered price rises and supply shortages, with disruption of delivery schedules. Full exploitation of plastic became an economic necessity and careful, long-range planning made the situation liveable. Plastic with a high use-value factor increased in use. Plastics of high quality became more prominent because their price rose at a comparatively slower rate and their higher strength permitted use for thin-walled parts. Decisions on materials had to be made at an early stage. In the future, limitations on grades may have to be accepted. Parts replacement would be facilitated by some standardization of color. Purchasing in bulk would smooth out price fluctuations. The sources, manufacturing processes and uses of thermoplastics, foam plastics, elastomers and thermosetting plastics are discussed, and illustrations are given of plastic automotive parts. The ultimate trend in plastics development and use in the automotive industry will only be visible after market stabilization.

by Hermann Hablitzel
Volkswagenwerk A.G., Germany
Rept. No. SAE-760173; 1976; 15p
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 636

A GUIDE FOR THE SELF-HEATING OF PLASTIC STRUCTURAL MEMBERS UNDER DYNAMIC PERIODICAL LOADS

For plastics under dynamic periodic stresses the following dimensioning criteria must be considered: the critical tensile and compression strain, and the upper temperature limit. Based on their viscoelastic properties, the temperature of plastic structural members under oscillatory loads rises during the loading time. When this temperature reaches a constant value, i.e. when an equilibrium between the supplied and delivered heat is established, the temperature rise can be calculated by the method here presented. Below the critical strain limit, the behavior of the self-heated material is similar to its behavior at corresponding increased environmental temperature. Thermic failure due to self-heating can be avoided by using the presented nomogram to determine the existing temperature difference. Factors in this formula are the form of oscillations, the geometry, the working loads and heat conduction. Using the creep diagrams corresponding to the respective temperature-difference, the resulting strain can be evaluated. If it exceeds the critical strain limits, fracture by shattering or nonstable failure can be expected. If it remains within the limits of the critical strain, however, tensile, compressive or alternated tensile and compressive failure can be avoided.

by N. Brand; G. Menges
Institut fur Kunststoffverarbeitung, West Germany
Rept. No. SAE-760175; 1976; 12p 14refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 637

THE CRITICAL STRAIN OF PLASTICS, IN PARTICULAR OF CHOPPED STRAND GLASS MAT REINFORCED PLASTICS UNDER HIGH RATES OF DEFORMATION

When critical strain limits for plastics are exceeded, irreversible microstructural damage occurs. Initial damage is as adhesion fractures at the boundary of the particles: in amorphous thermoplastics, flow zones develop, and in semicrystalline thermoplastics, microcracks occur. Such damage can be measured by several methods; a tabulation is made of their applicability and relative cost for amorphous thermoplastics, both high oriented and isotropic semicrystalline thermoplastics, and for both orthotropic and quasi-isotropic reinforced plastics. Penetration of coloring substances is advantageous because it is nondestructive and low in cost. However, it is disadvantageous because it can be used only for damage which has already reached the surface of the material. The method of volume dilatation is adequate for isotropic materials if accurate strain measuring has been made; however, it requires structural destruction. Measuring by the limit of the linear viscoelastic behavior is advantageous because it can be carried out along with other tests and requires no special arrangements, but disadvantageous because exact statements can be made only for well known loading conditions. Measurement of specific damaging energy is advantageous because it can be applied to long-time testing, but disadvantageous in that it requires a large number of specimens and in that exactness is possible only for simple loading conditions. Sound emissions measuring is very exact and allows the differentiation of the fiber fracture and matrix fracture; however, several recording systems are necessary and environmental noise can cause misinterpretations of measured values. Optical measurings are very exact, applicable to long-time experiments, and to very quick processes; however the cloudiness measuring procedure is applicable only for translucent materials, and needs to be compared with other tests. By means of a special example, the investigation of the microcracks development of a chopped strand glass mat reinforced UP-resin under uniaxial tensile loading up to high rates of deformation, it can be proved that even for extremely quick deformation

Availability: SAE

HS-019 638

NEW SOLUTIONS FOR THE TRIM OF AUTOMOTIVE VEHICLES

The cross linked polyethylene foam manufactured by Dynamit Nobel A.G. has the merits of good thermoformability, resistance to chemical agents and rotting, low weight, strength, price, and laminability to other materials. Since market research showed the motor car industry to be the best potential market for this material, the company developed new techniques and components for the trim in automotive vehicles, in cooperation with European auto manufacturers. Applications such as interior trim, roof lining (both adhesive and snap-in types), floor coverings, seats, interior/trunk partition, trunk and hood linings are described and illustrated. Other parts to be made of polyethylene foam, such as door and side panels, parcel tray and crash pad, will contribute to reduced weight and cost and increased comfort.

by Heinz-Gerd Reinkemeyer
Dynamit Nobel A.G., Germany
Rept. No. SAE-760177; 1976; 7p
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 639

MULTIPLEXING--PAST, PRESENT, AND FUTURE

Multiplexing has recently become of interest to the automotive industry and may be the only answer to the problems created by the increasing complexity of automotive wiring systems. A review of the history of the early and more recent developments in multiplex technology is presented and particular emphasis is placed on vehicular applications with respect to its advantages over conventional wiring systems. Multiplexing is space saving, it can provide the means for added vehicle features, installation and service operations should be greatly simplified, and it can save material and reduce vehicle weight. Some of the different multiplexing techniques which have been investigated for automotive applications are: amplitude discrimination; frequency discrimination; and time division discrimination. Electronic multiplexing as a technique for reducing vehicle wiring complexity is technically feasible today and may or may not be cost-effective depending on the application selected and the value of added features, installation cost, and warranty expense.

by Robert E. Bell
Essex International
Rept. No. SAE-760178; 1976; 8p 4refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

multiplexed control and monitoring systems by the military, particularly in aircraft. Use of optical fiber cable in control systems is under study in the automotive industry because of its advantages over multiplexing systems using copper wire control links: visible light signals sent through fiber optic cables are not subject to electromagnetic interference; fiber optic cables are relatively inexpensive, lightweight, and easy to repair in the field. Simplified wiring diagrams for an electro optical multiplexing control system (speedometer) are presented as well as information as to how such a system can be fabricated, installed and repaired. Examples of fiber optics monitoring systems are illustrated and explained. New terminology, such as "packing fraction," "pulse dispersion," "numerical aperature," "single mode versus multimode," and "high loss versus low loss," is discussed for the benefit of engineers, to facilitate the conceptual change from wiring and coaxial cables to photo-cybernetics with fiber optics.

by A. H. Brennesholtz; T. C. Balkenhol
Du Pont Co.
Rept. No. SAE-760179; 1976; 12p 11refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

HS-019 641

AUTOMOTIVE LOAD SWITCHING USING GATE CONTROLLED, SILICON CONTROLLED RECTIFIERS

A solid-state device, the gate-controlled, silicon controlled rectifier, or GTO SCR, that can be turned on and off by the application of a signal to its gate can be used in automotive electrical systems as a remote power switch to reduce the complexity and size of the wiring presently required. The implementation of a full multiplexed system must remain in the future, but the GTO can be used now in smaller systems that can ultimately be integrated into a full system. The GTO can control the loads typically found in an automobile and can effect a potential net decrease in wire sizes and the complexity of the switches needed. The potential uses of the GTO are limited only by the imagination of the circuit designer, for the GTO offers him the ability to implement features previously considered too expensive or complex. Sample circuits are described.

by J. Wojslawowicz
RCA/Solid State Div.
Rept. No. SAE-760180; 1976; 16p 2refs
Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.
Availability: SAE

front-seat occupants (575) using no restraints, wearing lap/shoulder belts (189), and automatically restrained by air bags (60). The results show that both air bags and lap/shoulder belts (when worn) substantially reduce the likelihood of death and serious injury to front seat occupants of full-size and luxury cars involved in frontal crashes. Also, as the severity of the crashes increases, the role of the restraint becomes very important. The Vehicle Deformation Index (VDI) was used to measure the extent of deformation and VDI's of 1-5 were chosen, 1 being the most minor, as these measured front-end deformation up to the windshield. Beyond that, restraint systems effectiveness is severely limited. The Injury Severity Score (ISS) was chosen in preference to the AID (Abbreviated Injury Scale) as the ISS was determined to give a far better indication of the overall severity of injuries, especially where the injuries are severe and involve more than one body region. Information on crashes, descriptions of injuries, and vehicle deformation were obtained from MDAI (Multidisciplinary Accident Investigation) reports received by NHTSA on or before 1 July 1976. Corresponding information on lap/shoulder belted occupants came from non-air bag MDAI reports on file in HSRI (Highway Safety Research Institute) and for both lap/shoulder belted and unrestrained occupants from Restraint System Effectiveness Program (RSEP) on file at NHTSA. In the less severe crashes studied (VDI's of 1 or 2), the average injuries to all three groups of occupants regardless of restraint, were very minor, e.g. aches, stiffness, bruises, scrapes, superficial cuts and sprains of the hand or finger, a measured ISS mean of less than 3. In the more severe crashes (VDI's of 3, 4, or 5), however, the average severity of the injuries to the unrestrained occupants increased dramatically, and many of the injuries were no longer minor. Some of the unrestrained occupants in these more severe crashes received fatal injuries. The average injury severities were reduced by 66% for the air bag restrained occupants and 55% for the lap/shoulder belted occupants in the more severe frontal crashes. The corresponding reductions in the likelihood of death in such crashes were 79% and 72%. These comparisons tend to confirm the laboratory testing results, indicating that air bags can offer better protection in frontal crashes than lap/shoulder belts, when worn, and substantially improved protection over no restraint. In frontal crashes, even compared to 100% lap/shoulder belt use, more lives could be saved and severe injuries reduced by the use of air bags.

by Dinesh Mohan; Paul Zador; Brian O'Neill; Marvin Ginsburg
Insurance Inst. for Hwy. Safety, Watergate 600, Washington, D.C. 20037
1976; 36p 45refs
Includes document 4, Recommendations. HS-019 643 is document 2; HS-019 644 is document 3.
Availability: Corporate author

HS-019 643

SELECTED POINTS CALLED TO THE SECRETARY'S ATTENTION 0ACTIVE AND PASSIVE

motor vehicle safety standard applying to belts and air bags should be followed: that "supplemental, active seat belt systems be provided for people who would use them for additional protection, over and above the baseline." Numerous precedents exist at DOT for requiring vehicle performance that becomes effective only when an emergency occurs. A number of prior standards exist that protect "only" in frontal crashes, as would an air bag, e.g. impact protection for the driver from the steering control system, and steering control rearward displacement which protects only the driver in frontal impacts only. Lives saved by bags and lives saved by belts are not entirely the same lives, and it has been shown that air bag passive crash protection is better than that provided by belts in frontal crashes (the source of the majority of occupant deaths) and vice versa for belts in other crash modes. Therefore Alternative IV calling for mandatory passive restraints should be adopted. Mandating vehicle safety standards has not in the past been associated with vehicle sales declines: death reductions, not sales reductions, have accompanied safety regulation. Two public opinion polls conducted by Sen. Packwood and by Detroit reporter Robert W. Irvin claimed little public support for air bags, but these results are scientifically invalid because the returns are statistically unrepresentative of the groups claimed to be sampled. An Insurance Institute for Highway Safety (IIHS) poll, scientifically conducted, on the other hand, found that people preferred crash protection that requires no activation by drivers and passengers each time they travel, and that people were willing to pay for such protection. Currently it is estimated that only about 30% belt use is the maximum likely to be achieved in the U.S. Air bags have been deploying in crashes of cars that have accumulated high mileages, and they continue to maintain enough air for adequate protection in multiple impact crashes. There have been no known cases in which air bags did not deploy in crashes as they were designed to do. In air bag deployment crashes, only about one-fifth of the front seat occupants have been belted at the time of the crashes. Vehicles already have several kinds of passive protection at lower speeds to which the proposed passive restraint requirements would be an additional and substantial improvement. Pertinent portions of other documents presented at the same time are included for emphasis.

by William Haddon, Jr.
Insurance Inst. for Hwy. Safety, Watergate 600, Washington, D.C. 20037
1976; 24p 15refs
Includes document 4, Recommendations. HS-019 642 is document 1; HS-019 644 is document 3.
Availability: Corporate author

HS-019 644

A CRITIQUE OF THE BENEFIT/COST ANALYSIS ACCOMPANYING THE ANNOUNCEMENT OF THE AUGUST 3, 1976 DOT PUBLIC HEARING ON MOTOR VEHICLE OCCUPANT CRASH PROTECTION. DOCUMENT 3

Major omissions in the DOT benefit/cost analysis are identified. Use of such analysis can be misleading if all costs

and all benefits are not included. The equation of 70% lap and shoulder belt use with the benefits of air cushions along with 20% lap belt use does not consider the superior protection of air cushions compared to lap and shoulder belts in severe frontal crashes and, separately, the need for lap belts in nonfrontal crashes. A level of 70% belt use, it is generally agreed, would be practically impossible to obtain in the U.S. However, if all cars were equipped with air cushions, and if 70% lap belt use could be obtained, a total of 14,700 lives would be saved annually--about 3,300 more lives per year than would be saved by 70% lap and shoulder belt use. Furthermore, relative use rates of lap and shoulder belts indicate that lap belt use is more easily obtained than shoulder belt use. DOT's assumptions as to fatality reductions that accompany given levels of belt use are not supported by the Ontario belt law experience. Not included in the DOT assumptions is the lowering of speed limits which reduced pedestrian deaths and more than likely vehicle occupant deaths as well. Therefore, even though deaths have failed to drop to levels expected from observed belt use, the lowering of deaths cannot be attributed to increased belt use alone. Moreover, observed belt use in Ontario has not been maintained at 70%, but has dropped from a high of 57% at the beginning of the observed period to a low of 33%. If social costs are not assessed along with actual dollar expenditures, results are misleading. For example, costs to individuals if belt use laws are mandated are not considered, yet they are substantial. Furthermore, if air bags were standard equipment rather than a purchase option, there is every reason to assume the public would be willing to accept the extra payment without outcry. The Insurance Institute for Highway Safety (IIHS) survey of new car buyers indicated that they were willing to add an average $12 per month to their new car payments to save 6,000 lives and even more to save 12,000 and 18,000 lives per year. Finally, it is faulty logic to say that individuals who already use both belts would be forced to subsidize those who do not. More correctly, if passive restraints were mandated, all front seat occupants would be protected; the approximately 30% of occupants who currently use active restraint systems would pay more for their cars but presumably gain some comfort and convenience by not having to wear upper-torso belts. The remaining 70% of occupants would get substantially improved occupant crash protection from the passive restraints with no change in their comfort or convenience.

by Brian O'Neill; Leon S. Robertson
Insurance Inst. for Hwy. Safety, Watergate 600, Washington, D.C. 20037
1976; 21p 16refs
Includes document 4, Recommendations. HS-019 642 is document 1; HS-019 643 is document 2.
Availability: Corporate author

HS-019 645

AUTOMOTIVE ELECTRONICS AND ELECTRIC VEHICLES. INTERNATIONAL CONFERENCE, PROCEEDINGS, (DEARBORN), 20-22 SEP 1976

A series of reports were presented at an international conference dealing with automotive electronics and advances in the development of electric vehicles. Twenty-four papers were read; a partial list of topics covered includes: LSI, microprocessors, and electronic automotive control; electromagnetic interference; sensors for new automotive systems; microwave solid-state devices for self-mixing Doppler radars; controls for electric vehicles; electronic engine control by on-board computer; integrated electronic systems; digital engine management; electronic lean burn system; recent advances in semiconductor logic and memory; advanced battery development; advanced electronic control systems; advanced motor developments; alternate propulsion systems for electric vehicles; and electric vehicle data.

Institute of Electrical and Electronic Engineers, Automotive Electronics Com.; Society of Automotive Engineers; Electric Vehicle Council; Institution of Electrical Engineers; Energy Res. and Devel. Administration; Univ. of Michigan
Rept. No. SAE P-68; IEEE 76CH11 46-O-VT; 1976; 153p refs
Includes HS-019 646--HS-019 660. Cover title: "Convergence 76. Proceedings, International Conference on Automotive Electronics and Electric Vehicles."
Availability: Corporate author

HS-019 646

LSI, MICROPROCESSORS AND ELECTRONIC AUTOMOTIVE CONTROL

The ability of LSI to implement complex digital control functions with a high reliability and low cost is having a significant impact on automotive systems, i.e. improving operating performance, economy, and safety. The present state of the art in integrated electronics with regard to electronic automotive control is examined, and illustrations depict a typical control system which interacts with the vehicle via the sensors and actuators which are shown. Both digital-output sensors and analog-output sensors are shown. The important factors governing the choice of a technology include cost, reliability, immunity to environmental influences, speed and power. The several competing LSI technologies are compared in terms of their ability to meet these and other automotive requirements. A variety of technologies has been used for processor implementation, each representing a different tradeoff between cost and performance. The major LSI technologies are: TTL; I squared L (an integrated injection logic); pMOS (boron metal-oxide-silicon); nMOS (phosphorus metal-oxide-silicon); and CMOS (complementary MOS), and are also compared in terms of their process complexity and required gate areas. All of these technologies have been used for microprocessors. At present, of the LSI technologies, pMOS is the simplest, nMOS is the most widely used, and TTL is probably the fastest. CMOS offers the lowest power, highest noise, and environmental immunity, and is fairly fast, but relatively expensive in terms of silicon area and process complexity. I squared L offers low power, high speed and high density, but does not have proven yields at this time. Recent developments and trends applicable to next generation control systems are assessed. Graphs and drawings illustrate various aspects of LSI technology.

by K. D. Wise
University of Michigan, Dept. of Electrical and Computer Engineering, Ann Arbor, Mich. 48109
Publ: HS-019 645, "Automotive Electronics and Electric Vehicles." International Conference, Proceedings, New York, 1976 p 1(1)-1(5)
1976
Conference held in Dearborn, 20-22 Sep 1976.
Availability: In HS-019 645

HS-019 647

ELECTROMAGNETIC INTERFERENCE IN AUTOMOBILES

Electromagnetic interference (EMI) is shown to be a potentially serious threat to certain electronic systems, and some countermeasures are presented which may be helpful in reducing the effect of EMI to possibly acceptable levels. Of the two major categories of auto-related EMI, only interference in internal auto electronics systems by electrical activity of other devices in the car or from outside the car is considered in this survey. The three mechanisms include conductive coupling, the coupling of interfering signals into a susceptible device by means of a common impedance element to the interfering and susceptible circuits. In radiative transfer, EMI can reach a susceptible device by radiation from r-f sources when one or more of the leads connected to the susceptible devices acts as an antenna to receive the EMI from sources inside or outside the vehicle. The fundamental principle involved in quasistatic magnetic coupling is the mutual inductance between any pair of current carriers. Schematic drawings illustrate the three major mechanisms.

by William B. Ribbens
University of Michigan, Electrical and Computer Engineering, Ann Arbor, Mich. 48109
Publ: HS-019 645, "Automotive Electronics and Electric Vehicles." International Conference Proceedings, Dearborn, Michigan, 1976 p2(1)-2(3)
1976
Conference held in Dearborn, 20-22 Sep 1976.
Availability: In HS-019 645

HS-019 648

SENSORS FOR THE NEW AUTOMOTIVE SYSTEMS

The reasons that low cost sensors suitable for automotive control systems are generally unavailable at the present are analyzed, and factors are defined that are inhibiting their development. Sensor cost reduction strategies include the conventional strategy which will require large investments in engineering redesign, manufacturing engineering, capital equipment, and tooling; and an alternative strategy which requires adaptation of a sensor concept that is amenable to manufacturing techniques having a demonstrated economy at the required production volume. A description is provided of the ways in which conventional and alternative cost reduction strategies have been or are being applied to the design of a manifold-absolute-pressure (MAP) sensor currently incorporated in a domestic speed/density electronic fuel injection system. The design described, which is employed to manufacture the silicon-diaphragm strain-gage pressure sensor, is felt to be the approach which will eventually result in automotive sensors that can be produced in large quantities at low cost. The forms are examined which future sensor and interface designs will tend to take as automotive control systems become digitally organized, and the cost and characteristics of future analog-to-digital converter electronics are discussed to assess which interfaces are likely to remain analog. It is concluded that instrument developers can best meet production cost constraints by designing satisfactory sensors around existing, highly cost-effective production processes.

by William G. Wolber
Bendix Res. Labs.
Publ: HS-019 645, "Automotive Electronics and Electric Vehicles." International Conference Proceedings, Dearborn, Michigan, 1976 p3(1)-3(6)
1976; 12refs
Conference held in Dearborn, 20-22 Sep 1976.
Availability: In HS-019 645

HS-019 649

MICROWAVE SOLID-STATE DEVICES FOR SELF-MIXING DOPPLER RADARS

Doppler radars at microwave frequencies have been and will continue to be used for measurement of distance, speed, and the presence of an object. There are two types of systems which can be employed in automotive applications; one utilizes an external mixer to detect the doppler frequency signal and the other utilizes a single device for both transmission and reception of the signal and is referred to as a self-mixing doppler radar. This is the system discussed; of primary concern are the microwave devices that can be employed in such a system. The properties of three devices that can be used in automotive applications are considered. These devices are Gunn, IMPATT (impact ionization avalanche transit time), and BARITT (barrier injection transit time). The properties of these devices which are the most pertinent to automotive applications include: cost and reliability; prime power requirements; operating voltage and current; radiated power; conversion loss; AM noise, and operating frequency. All three devices are capable of generating adequate amounts of power for many of the automotive applications up to very high frequencies. Since a great deal of data are available at x-band frequencies, this is the range discussed. The basic properties of the devices are discussed and their basic structures are mathematically illustrated. When all three devices are placed in a proper microwave circuit and biased at the proper operating point, they can be used as oscillators. Microwave oscillators and their use in self-mixed doppler radars are discussed. The three devices have been tested in a doppler-type system to compare their performance. Results of a comparison between characteristics of the three devices are tabulated, comparisons were made at 100 Hz and 3 kHz frequencies, and show that the BARITT device has many advantages over the other devices in the applications considered. Tabulated material illustrates the characteristics of the three devices.

by G. I. Haddad; H. Nguyen-Ba; J. R. East
University of Michigan, Electron Physics Lab., Ann Arbor, Mich. 48109
Publ: HS-019 645, "Automotive Electronics and Electric Vehicles." International Conference, Proceedings, Dearborn, Michigan, 1976 p4(1)-4(5)
1976; 2refs
Conference held in Dearborn, 20-22 Sep 1976.
Availability: In HS-019 645

HS-019 650

CONTROLS FOR ELECTRIC VEHICLES

A review is presented of the various methods currently in use to regulate the voltage delivered to the drive motor in electric vehicles. This is the basic function of the controller in such a

and cost of the various methods are considered. The major emphasis is placed upon controllers for use with DC traction systems but a brief review of controllers for AC systems is included. In both cases, it is assumed that the power source is a DC supply. Three basic control methods for DC traction systems are described: the variable resistance control is simple but disadvantageous because it is wasteful of energy and tends to produce a jerky motion in the vehicle as the various resistors are stepped through by the controller; the battery switching control eliminates the waste of dissipated power in the resistance control but also produces jerky vehicle motion; the battery scanning control also produces jerky vehicle motion; and the chopper control, a high frequency current interrupted method, tends to produce a high frequency noise. The various types of drive motors available are described. The selection of a particular control scheme may be dependent upon the drive motor to be used. The three types of DC motors in use in electric vehicles today are: the separately excited; the series-wound; and the compound-wound motor. Many different traction systems are in use today which utilize different combinations of the basic control methods and motors discussed. The most common uses the electronic chopper control in conjunction with a series-wound motor. AC traction systems are ruled out in favor of DC systems due to the cost and complexity of the AC controller required. Schematic drawings illustrate the functions of the control systems.

by Gene E. Smith
University of Michigan, Dept. of Mechanical Engineering
Publ: HS-019 645, "Automotive Electronics and Electric Vehicles." International Conference Proceedings, Dearborn, Michigan, 1976 p5(1)-5(7)
1976; 11refs
Conference held in Dearborn, 20-22 Sep 1976.
Availability: In HS-019 645

HS-019 651

ELECTRONIC ENGINE CONTROL BY ON-BOARD COMPUTER

The ability to provide for interaction between control variables is probably the greatest functional advantage, in terms of cost effectiveness, which a programmable computer possesses over mechanical control hardware. The computer has the ability to achieve a new approach to the dilemma brought about by mass produced engines made by a given calibration, subject to production tolerances which result in thousands of different combinations of individual calibrations. This approach is called adaptive control. If a description of the desired relationship between the control variables and the operating variables which can be quantified by sensors can be made in mathematical form, the computer can adapt to the measured conditions. Examples of the concept of adaptability include its application to the automatic speed control available on many cars. A more complex example is provided in automatic transmission shift control where the computer can assist in providing a constant acceleration shift by using inputs previously determining engine speed and torque. Computer control systems would achieve the same reliability of operation as mechanical devices under widely varying environmental conditions and operator demands through thorough inspections with environmental extremes, burn-ins to reduce early failures, and designs for "graceful" degradation. The task visualized for the future of the programmable computer is to take advantage of control grammed to display all of the information a driver needs in a more efficient manner than available today. It may also be possible to construct a computer device to act as a navigational aid. It is felt that the future of automotive usage of microprocessors is unlimited.

by David F. Moyer
Ford Motor Co., Systems Res. Lab.
Publ: HS-019 645, "Automotive Electronics and Electric Vehicles." International Conference Proceedings, Dearborn, Michigan, 1976 p16(1)-16(5)
1976
Conference held in Dearborn, 20-22 Sep 1976.
Availability: In HS-019 645

HS-019 652

INTEGRATED AUTOMOTIVE ELECTRONIC SYSTEMS

Engine control is beginning to improve automobile value, and electronics is being used for control systems in order to meet emission and energy conservation requirements. Electronic systems are now used for control of fuel-air ratios and of spark timing, and can expand the scope of transmission shift point control systems from simply rpm, velocity, and torque to other pertinent variables. Any integrated electronics system will need to be examined in the light that it must increase the value of the vehicle to the owner, and any candidate vehicle technology must be able to stand up to environmental factors, be available in time and amount for the vehicle it is programmed for, be serviced easily in the field, and be durable and reliable. "Fail safe" concepts must be incorporated into future systems, and they must be as or more reliable as current mechanical systems in order to sell. Parts must be readily available to manufacturers so that assembly lines will not be slowed down. Some parallels and some differences between four new electronic systems unrelated to automotive use and integrated automotive electronic systems are examined. Both types of systems are relatively complex, valuable enough that people will pay for them, and inexpensive enought to be bought in measurable quantitites. The major difference between the two types of systems is the lack of stand alone capability of integrated automotive electronic systems; these systems depend on other systems to function. The prospects for the future of automotive electronics are examined. Advances will come through concentrating on fundamental engineering principles and all advances will have to increase the value of the vehicle to the buyer.

by John T. Auman; Ronald L. Colling; Stephen P. Stonestreet
General Motors Engineering Staff, Warren, Mich.
Publ: HS-019 645, "Automotive Electronics and Electric Vehicles." International Conference Proceedings, Dearborn, Michigan, 1976 p17(1)-17(7)
1976
Conference held in Dearborn, 20-22 Sep 1976.
Availability: In HS-019 645

HS-019 653

DIGITAL ENGINE MANAGEMENT

A review is presented of the characteristics of current digital engine management systems, and a contrast is made between

digital signals and that sensor-and-actuator development will be slower than digital-control-unit development. Also, digital engine controls must be designed to exploit semiconductor technology and the flexibility inherent in digital systems to realize their full potential. Control-unit production calibration is seen to be a key element in the design of engine management systems and is materially expedited by the use of digital technology. Seven issues are discussed which will have to be confronted in the move from analog to digital engine control, and each discussion is followed by suggestions for their solution. The issues serve to put into perspective the scope of what yet needs to be accomplished in the field; they are: microprocessor bit width and interior decor; control-law representation; engine control optimization and adaptation; mode-shifting; multiple-microprocessor architecture; drive-by-wire potential; and the control-configured-vehicle concept.

by John W. Weil
Bendix Corp.
Publ: HS-019 645, "Automotive Electronics and Electric Vehicles." International Conference Proceedings, Dearborn, Michigan, 1976 p18(1)-18(8)
1976; 1ref
Conference held in Dearborn, 20-22 Sep 1976.
Availability: In HS-019 645
1976
Conference held in Dearborn, 20-22 Sep 1976.
Availability: In HS-019 645

HS-019 655

RECENT ADVANCES IN SEMICONDUCTOR LOGIC AND MEMORY

The technology of logic circuits has advanced to the point where complex functions called large scale integration (LSI) have been developed. Much of the LSI logic functions which have been developed in the past two years have been microprocessor oriented. The microprocessor has become the vehicle for the solution of the electronics industry's custom problems by utilizing standard hardware which is programmable through the use of vendor supplied software. Costs of the range of applications of the microprocessor are diverse, but it is already possible to pay as little as $5.00 for microprocessor solutions. Soon there will be at least one in every automobile and more than one in every home. The two-chip F8 is the most cost-effective in today's market and has been designed to fit many high volume, low cost applications. The eight-bit metal oxide silicon (MOS) microprocessors are cost-effective, but are limited in performance capabilities. Injection logic (I squared L), a new Bipolar LSI technology, is important for the future because it has the capability of combining Bipolar performance with the power and packing density capabilities equivalent to MOS. Advances in semiconductor memory are treated and the discussion is prefaced with a listing of the three basically different semiconductor technologies utilized in memory. They are: Bipolar technology, MOS technology, and charged coupled devices (CCD). Much excitement is being generated by the potential of a 4,096-bit Bipolar injection logic random access memory (RAM) which utilizes an isoplanar in-

by T. A. Longo
Fairchild Camera and Instrument Corp., Mountain View, Calif.
Publ: HS-019 645, "Automotive Electronics and Electric Vehicles." International Conference Proceedings, Dearborn, Michigan, 1976 p20(1)-20(6)
1976
Conference held in Dearborn, 20-22 Sep 1976.
Availability: In HS-019 645

HS-019 656

ADVANCED BATTERY DEVELOPMENT

A report on the status of advanced batteries being developed for vehicle propulsion is presented. Lead acid, nickel zinc, nickel iron, zinc air, sodium sulfur, and lithium metal sulfide batteries are discussed as they seem to have the greatest near- and longer-term merit. Battery performance requirements for an urban as well as a highway passenger vehicle are outlined and the power and energy characteristics of the lead acid battery and the nickel zinc battery are plotted against the battery requirements of an urban vehicle. It is found that lead acid batteries do not provide high electrical performance but are of low cost when compared to that of improved batteries. The present nickel zinc system would propel a vehicle satisfactorily, but is high in cost. It is concluded from electrical performance data that a credible urban vehicle can be built based on improved battery technology. In the near term, the stage is set for a conflict between electric vehicle performance and cost involving the use of lead acid versus nickel zinc batteries. In the future, electrochemical systems are expected to emerge which will better accommodate cost and performance. Significant government support will be required to continue and accelerate the development of advanced batteries as the long development cycle and high cost are not acceptable in a corporate funded activity.

by Neal A. Richardson
Energy Systems Group of TRW, Inc., Redondo Beach, Calif.
Publ: HS-019 645, "Automotive Electronics and Electric Vehicles." International Conference Proceedings, Dearborn, Michigan, 1976 p21(1)-21(7)
1976; 8refs
Conference held in Dearborn, 20-22 Sep 1976.
Availability: In HS-019 645

HS-019 657

ADVANCED ELECTRONIC CONTROL SYSTEMS FOR ELECTRIC VEHICLES

The characteristics and relative advantages of several types of control systems for commuter-type electric vehicles having a top speed in the 55 to 60 mph range and 0 to 40 mph acceleration times in the range of 20 seconds are discussed. The armature chopper control system has the ability to provide smooth control over a wide range of motor speed and the voltage applied to the motor can be varied continuously from 0 volts to full voltage by controlling the conduction ratio of thyristor

some of which are: to provide smooth transitions between parallel and series battery connections; to provide good low and high speed control; to provide adjustable regenerative braking; to minimize power losses; and to be compatible with large scale integration. Performance characteristics of an electric vehicle using this control are discussed and performance comparisons are presented in table form. The range of improvement of the field control system with respect to the armature chopper is partially due to regeneration and partially due to elimination of battery losses caused by the pulsed chopper waveform. Acceleration performance improvement results from improved torque availability and the elimination of manual gear shifting. The savings in size, weight, power dissipation and cost of the field control system are also important advantages. Full realization of the potential of battery powered electric vehicles will require substantial improvements in battery energy and power density, the development of lightweight, high performance motors and further controller improvements. Tabulated material presents characteristics of several motor types, some functions of the field control system, and a photograph of the electric vehicle employed in the study.

by Francis T. Thompson
Westinghouse Res. Labs., Pittsburgh, Pa.
Publ: HS-019 645, "Automotive Electronics and Electric Vehicles." International Conference, Proceedings, Dearborn, Michigan, 1976 p22(1)-22(9)
1976; 7refs
Conference held in Dearborn, 20-22 Sep 1976.
Availability: In HS-019 645

HS-019 658

ADVANCED MOTOR DEVELOPMENTS

Progress in electric vehicle motors should be based on consideration of the total power train: the motor should be capable of high efficiency in the regenerative mode; it should be suitable for low-cost mass production; and, it should, if possible, be able to be directly coupled to the driving wheels, thereby allowing the jobs of power transmission and torque-speed matching to be done electrically and electronically. Trends in advance motor development that will impact on such technical needs offer exciting possibilities. The "first generation" goals of electric vehicle design can probably be met with present DC technology. In particular, the DC shunt drive motor looks attractive because of its ease of control in the regenerative mode, as compared with the DC series type machine. Coupled with recovery of braking energy, it shows potential for significant improvements in range. Potential advantages of AC drives will have to be continually evaluated as advances in microprocessors and other solid-state technologies continue to develop. Developments are now underway on the disc-type permanent magnet electrical machine which in the future may offer the possibility of reducing the total weight and size of the system, while improving performance. Extensive tests will be required to establish its benefits. At present it is expensive because of the cost of the rare-earth material

Conference held in Dearborn, 20-22 Sep 1976.
Availability: In HS-019 645

HS-019 659

ALTERNATIVE POWERPLANTS

The gas turbine and the Stirling cycle system are currently the two most important contenders as alternatives to the internal combustion engine; both are continuous combustion systems. Any new engine design must meet the legal restraints of the Energy Policy and Conservation Act concerning fuel economy. Ways in which the internal combustion researchers are approaching the problem include work on the three-way catalyst, advanced carburetion techniques, new valving arrangements, and how to accomplish conventional lean burn and lean burn with stratification. Public opinion is apparently less concerned with the type of engine than with ease of operation, low maintenance, and reasonable fuel economy. As for the gas turbine engine, most interest for future development lies in the open-cycle, Brayton-free turbine because of its potential to give high fuel economy, low exhaust emissions, and its ability to run on almost any fuel. Use of ceramics in the stationary and hot parts of the turbine needs to be accomplished. A tabulation is made of current status of turbine technology on a component basis (compressor, gasifier turbine, power turbine, combustor, regenerator, controls, and transmission) and an extrapolation of potential benefits from technological improvements. Turbine engines currently under development include the Chrysler 7th generation engine, the Mature engine, and the Advanced engine. The Stirling cycle engine is a closed cycle, external combustion engine which has the highest theoretical efficiency and fuel economy of any other engine. Currently Ford Motor Co. and Philips are working on prototypal development. Problems which need to be overcome include diffusion of the hydrogen working fluid through storage vessels, seals, etc.; complex engine control systems; high heat rejection with attendant large radiator requirements; and high cost of materials and assembly. Tabulation is given of some key design characteristics (working fluid, heater head, cycle regenerator, cycle cooler, pistons, rod seal, block, swash plate, preheater, power control system, and transmission) and the projection of effects on engine design of advanced ceramics and other improvements. An educated guess on the improvements that could be demonstrated by 1981/82 for the Mature Turbine and Stirling engines and for the improved conventional engine is presented in tabular form. For both the free turbine and Stirling engines, the future depends on improved ceramics (high-temperature, low in cost) and component efficiency improvements.

by John J. Brogan
Energy Res. and Devel. Administration
Publ: HS-019 645, "Automotive Electronics and Electric Vehicles." International Conference, Proceedings, Dearborn, Michigan, 1976 p24(1)-24(5)
1976; 2refs
Conference held in Dearborn, 20-22 Sep 1976.
Availability: In HS-019 645

brakes, performance including speed and range, seat, springs, suspension, steering, tires, cargo space, price, and miscellaneous added features. Data are given as submitted by the manufacturers; photographs are provided. The vehicles include automobiles, vans, small trucks, buses, and a windmobile.

by Ming-Chih Yew, ed.
Engineering Staff, General Motors Corp.
Publ: HS-019 645, "Automotive Electronics and Electric Vehicles." International Conference, Proceedings, Dearborn, Michigan, 1976 p25(1)-25(30)
1976
Conference held in Dearborn, 20-22 Sep 1976.
Availability: In HS-019 645

HS-019 661

FEASIBILITY STUDY OF IN-DEPTH ACCIDENT INVESTIGATION TEAMS

In response to the NHTSA urging for states to move toward the establishment of in-depth accident investigation teams, the results of a feasibility study to establish such a team in North Carolina are presented. The report recommends the following: teams should be established and each team should be composed of a full time researcher in highway safety who serves as team coordinator; a senior level highway safety researcher who is available to provide continuity of coverage on a part time basis; a full time highway engineer with expertise in automotive engineering whose primary responsibilities are the collection and analysis of vehicle and roadway data; a part time registered nurse who collects medical data on persons injured in the crashes by examining the individuals' medical records; a part time mechanic available on a consulting basis when additional automotive expertise is needed; and part time technical and support personnel. Each full time team member should receive official training in multidisciplinary accident investigation, and in the administration of first aid, appropriate photographic techniques, and police radio usage. Equipment should be made available to team members for the purposes of photography, communications, transportation, lighting, data gathering and measuring, safety, and vehicle handling and repair. The cost of establishing and maintaining a team based at a research agency is estimated to be approximately $75,000-80,000 annually with funds being expended in the areas of personal services, equipment, training, and travel and subsistence. Medical data, vehicle data, roadway data, and accident data should be gathered by team members and recorded in both coded and narrative form. Care must be given to the deletion of any information which could lead to the identification of individuals involved in any particular accident. A pilot team should be established during the upcoming fiscal year to investigate school bus crashes. If the MDAI team is found to be effective, statewide multidisciplinary accident investigation teams should be established the following year. For other interested states, the report recommends initial statewide contacts with individuals and agency spokesmen representing the medical, enforcement, and automotive fields as cooperation is imperative and handling some medical data is often a sensitive issue. Consideration should be given to the presently existing of police, cost estimates for necessary equipment, and a tentative budget for establishment and operation of a MDAI team.

by Catherine B. Mullen; J. Steven Desper; John H. Lacey
University of North Carolina, Hwy. Safety Res. Center, Chapel Hill, N.C.
1976; 153p 10refs
Availability: Corporate author

HS-801 518

EXAMINATION OF COLLISION VEHICLES

A valid crash study requires both global data such as can be put into standardized format and specific data concerning individual factors needed to construct the complete crash scenario. An investigator must preserve perishable evidence (tire marks, spilled vehicle fluids); obtain and correlate information using logic, a priori knowledge and experience, the significance of relevant factors, and cause and effect relationships; conceptualize crash dynamics using at-crash data; select the logical critical path by following a clue, chain of evidence, or vehicle failure data provided in a system like CROSSTABS; review case facts in two or three-dimensional crash factor matrices; analyze data mathematically and graphically in models using trajectory deformation, skids, property damage, for example; and adequately document the findings in a concise structured report containing photographs, tables, graphs, and drawings. Six case studies are described and photographically illustrated as examples of these factors.

by David N. Schmidt
Traffic Safety Res. Corp.
Publ: HS-801 979 (ZQ-5731-V-1), Motor Vehicle Collision Investigation Symposium Vol. 1: Proceedings, 1976 p208-42
1976; 2refs
Availability: In HS-801 979

HS-802 021

DEVELOPMENT OF IMPROVED INFLATION TECHNIQUES. VOL. 1. FINAL REPORT

A dual bag inflation design of air bags is developed in the hope of providing up to a 50 mph frontal crash protection for frontseat passengers. It consists of a low pressure, aspirator filled head bag and a high pressure, augmented filled torso bag, with the knees cushioned by a fixed crushable restraint. Results of 39 sled tests and 6 full scale vehicle tests suggest that the dual bag design can probably be effective in meeting MVSS 208 injury criteria at speeds up to 45 mph. Satisfactory static as well as dynamic tests were made of this form of passive restraint system, and all results tabulated. The all pyrotechnic reloadable inflator is diagrammed.

by J. T. Johnson
Olin Corp., Engineering and Devel., Marion, Ill. 62959
Contract DOT-HS-345-3-691
1976; 55p
Rept. for Jul 1974-Sep 1975.
Availability: NTIS

the Task Force on Adjudication to concentrate on three aspects of the adjudication and sentencing of drinking driver cases in the nation's lower courts: sentencing systems designed since 1971 by the jurisdictions cooperating with the ASAP (Alcohol Safety Action Program): judicial education in alcohol and highway safety; and related activities of the Department of Justice Law Enforcement Assistance Administration (LEAA), the Department of Health, Education, and Welfare, the American Bar Association, and the American Judges Association. The following elements of adjudication are listed and described: legislation; enforcement; prosecution; defense services; and trial. Sanctioning approaches include diagnostic evaluation and driver license records integrity maintenance. There was found to be widespread disagreement at the local level about the effectiveness or ineffectiveness of all types of sanction. The Task Force found continuing confusion about the use and effectiveness of traditional statutory sanctions against drinking drivers. Referral to alcohol safety schools is by far the most frequent alternative sanction in jurisdictions associated with ASAP and there was found to be striking enthusiasm among local court and treatment personnel for ASAP supported rehabilitation modalities. ASAP had dramatically increased the use of probationary authority in drinking driving cases and substantially changed the concepts of its purpose. Much variety in court structure, authority, and resources, and an equally complex set of national level recommendations for court reform was encountered. The Task Force recommends that NHTSA correlate the real-world experience of the ASAP's with existing professional standards concerning the courts; identify where there is clear agreement, where cooperation would be of mutual benefit, and where existing disagreements may be adjusted. The handling of drinking driving cases is adversely affected by unqualified or uninformed adjudicators. Large differences exist between adjudicators connected with an ASAP and those not so connected. The system management concept used by ASAP has successfully established liaison among agencies at the local level, cooperation has begun at the state level, and relationships at the Federal level need strengthening. Task Force recommendations are summarized in 35 items, a membership list of the Adjudication Task Force precedes the report, an appendix contains a list of the educational packages designed for personnel within the criminal justice system supporting the ASAP concepts, and a listing of sources of ASAP reading material is supplied.

National Hwy. Safety Advisory Com., Adjudication Task Force, Washington, D.C. 20590
1976; 29p
Availability: Corporate author

HS-802 024

MOTOR VEHICLE SAFETY DEFECT RECALL CAMPAIGNS--DETAILED REPORTS FROM JANUARY 1, 1976 TO MARCH 31, 1976

Detailed information regarding defect recall campaigns conducted by 37 domestic and foreign automobile, tire, and equip-

HS-802 025

NATIONAL PARTS RETURN PROGRAM. VOL. 1. FINAL SUMMARY REPORT

by Bruce Beddew; J. Peizer; G. Whiddon
Kappa Systems, Inc., 1501 Wilson Blvd., Arlington, Va. 22209
Contract DOT-HS-5-01166
1976; 22p
For abstract, see HS-802 026. Rept. for 1 Jul 1975-30 Jun 1976.
Availability: NTIS

HS-802 026

NATIONAL PARTS RETURN PROGRAM. VOL. 2. FINAL TECHNICAL REPORT

The National Parts Return Program involves the voluntary submittal by independent automotive repair shops of failed automotive components, in order to gather information on these components to assist the NHTSA to identify the existence of safety-related, manufacturing defects in design, materials, and construction on the performance of motor vehicles and motor vehicle equipment. Under authority of the National Traffic and Motor Vehicle Safety Act of 1966, and amendments to the Act in 1974, the NHTSA can require manufacturers to conduct safety-defect notification campaigns when it has been determined that a defect relating to motor vehicle safety exists. In addition, the information obtained from these parts is valuable in preparing Federal Motor Vehicle Safety Standards. A total of 232 individual shops contributed 942 failed parts to the program during the contract period. The failed parts received during the period covered 39 separate and distinct assembly areas, a listing of which is provided in the final report of the program period, together with a detailed identification of the part received, and the quality of each. The area of brakes--hydraulic system represents the largest percentage of the total received, with 24.3%, and the area of the engine was second, with 14.0%. A cumulative report is provided of all of the parts received by the Parts Return Program from 1 July 1975 through 30 June 1976. The records in this report are grouped by component classification. A copy of the PRP Newsletter is included; it served to educate and motivate the Parts Return Program enrollees to submit failed parts, stated the program's objectives and operation, and informed enrollees of which parts are needed for the program, what a safety-related defect is, and what the Parts Return Program accomplishes for the NHTSA and highway safety. Also attached is a sample auto repair shop questionnaire used for the initial contact with the shop owner and a copy of the DOT introductory letter sent to prospective Parts Return Program participants.

by Bruce Beddow; J. Peizer; G. Whiddon
Kappa Systems Inc., 1501 Wilson Blvd., Arlington, Va. 22209
Contract DOT-HS-5-01166
1976; 245p
For summary, see HS-802 025. Rept. for 1 Jul 1975-30 Jun 1976.
Availability: NTIS

mits of reasonable extrapolation, the more likely settings
/ithin which the safety community will have to operate,
)gether with some of the problems with which they will have
) contend. Projections of overall traffic fatalities as well as
atalities in some of the principal traffic system components
/ere made. Estimates were derived by superimposing certain
uantifiable perturbing factors on a base line extrapolation of
istorical experience. Prime among these factors were speed,
ehicle mix, and alcohol. This approach was combined with an
nalysis of the NHTSA Fatal Accident Reporting System
FARS) data files. The FARS was used as the principal source
f data; and, thus, the outlook has a heavy bias to the fatal ac-
ident picture. The projections assume that the current safety
rograms will be carried on at present levels of effort and ef-
ectiveness. The youthful driver problem is expected to
iminish slightly due to shrinkage of this age group and to be
upplanted by an older driver problem. All signs point to a
/orsening of the safety outlook with respect to motorcycles,
mall cars and trucks. It is projected that overall traffic fatali-
es will reach 67,000 in 1990 (compared to 46,800 in 1975).
Inderlying this estimate are assumptions that there will be a
ubstantial shift to smaller cars, that speed patterns will not
naterially change and that per capita alcohol consumption will
ot grow as rapidly as in the past several decades. Injury and
roperty damage accidents are expected to grow roughly in
roportion to the fatality trend. However, it is likely that the
everity of injuries will decrease as a result of more crash-
/orthy vehicles and safer roadway features. A slight increase
1 the pedestrian fatal accident rate can be anticipated due to a
hift toward an older population. Deaths may number well
bove 11,000 compared to the current figure of 8,200. It is pro-
ected that there will be about 2,000 bicyclist fatalities in 1990
ompared to little more than 1,000 in 1975. Motorcyclist deaths
1 1990 will be around 5,200 compared to about 3,250 in 1975.
)ccupants of trucks and buses would not fare relatively worse
1 the future than today. However, if truck sizes and weights
re permitted to grow, then occupant deaths in those vehicles
/ith which trucks collide can be expected to climb (10,000
)day to as high as 16,000 in 1990). Bus related death patterns
hould continue to constitute a minor safety problem in terms
f magnitude.

lational Hwy. Traffic Safety Administration, Office of
lanning and Evaluation, Washington, D.C. 20590
976; 40p 9refs
vailability: NHTSA

IS-802 028

URVEY OF SUSPENSIONS. ANALYSIS OF TONGUE /EIGHT DISTRIBUTION AND TOW VEHICLE AND 'RAILER. REPORT NO. 14. FINAL REPORT

tatistical results are presented of a survey of recreational
ehicles at campsites to determine the actual trailer tongue
/eight applied to a towing vehicle in highway use, due to the
se of weight-distribution hitches. Data are organized both by
ie maximum coupler vertical load capacity allowed according
) the SAE trailer gross weight classifications and by tow
ehicle type (auto and truck). Average loads distributed to
tion hitches are not always adjusted to distribute only the ton-
gue load. The average distributed load for all vehicles is rela-
tively close to the average tongue load. Scale accuracy was
within 1% of the weight reading; three repeatability checks
were made. An appendix presents a printout of a listing of
weight distribution in pounds per vehicle, including data on
tongue load, coupler capacity, and axle and tire/wheel distribu-
tion.

by Norman Ludtke
Pioneer Engineering and Mfg. Co., Warren, Mich.
Contract DOT-HS-4-00978
Rept. No. PEMC-54-55-A; 1976; 185p 3refs
Rept. for Jul 1971-Jan 1976. See HS-800 979 and HS-801 100
for further information on the results of the original survey.
Availability: NTIS

HS-802 029

YOUTH ALCOHOL SAFETY EDUCATION CURRICULUM FOR THE SECONDARY SCHOOL. FINAL REPORT

The preparation and pilot evaluation of an educational publica-
tion designed for use in secondary schools, "You...Alcohol and
Driving," is described in detail. The work had eight phases:
definition of the youth alcohol safety problem, formulation of
alcohol education objectives, preparation of instructional
specifications, development of a preliminary instructional pro-
gram, conduction of a pilot test evaluation, development of a
final program, preparation of an implementation plan, and
preparation of an evaluation plan. The program was designed
for new drivers in a student-centered group setting in which
attitudes towards and responsibility for drinking drivers might
be favorably altered. The eight-hour program, using outside
reading materials written at a sixth to eighth grade reading
level, also included a unit of material on drug use and driving.
A pilot test of the program on ninth and tenth grade students
showed a statistically significant (15%) knowledge gain and a
highly favorable reaction. Promotion of the program through
appropriate government and private organizations and an
evaluation of long-term effectiveness are encouraged. Several
tests and questionnaires are appended.

by Kenard McPherson; Sarah Ashburn; Anne Knipper
National Public Services Res. Inst., 421 King St., Alexandria,
Va. 22314
Contract DOT-HS-5-01195
1976; 129p 20refs
Rept. for 1 Jul 1975-14 Jul 1976.
Availability: NTIS

HS-802 031

MULTIPURPOSE MOBILE INSPECTION VAN DESIGN AND CONSTRUCTION OPERATION MANUAL. FINAL REPORT

A description of, and operating instructions for, a mobile
motor-vehicle inspection facility deals with vehicle operation

toe gauge. Three layouts are prescribed for setting up the three stations and the reception area: they require dimensions of 125 ft x 30 ft, 100 ft x 85 ft, or 85 ft x 85 ft, respectively. Tabulated directions for making the 95 different vehicle inspections are thorough.

by F. G. Fisher
Ultrasystems, Inc., 500 Newport Center Drive, Newport Beach, Calif. 92660
Contract DOT-HS-093-2-482
1976
Rept. for Jun 1972-Aug 1973.
Availability: NTIS

HS-802 032

TEST PROGRAM TO DETERMINE PERFORMANCE CAPABILITY OF WHEEL/RIM ASSEMBLIES. FINAL REPORT

An investigation was conducted to obtain preliminary data on wheel and rim assemblies for a proposed Federal Motor Vehicle Safety Standard and also to provide verification of test methods used by industry. Dynamic fatigue, dynamic cornering fatigue 90°, and dynamic cornering fatigue 40° testing were performed. In general the test procedures followed SAE specifications (SAE-J328A and SAE-J267). These tests will need clarification and revision before being used for compliance testing by DOT. This is especially true if all wheels must undergo all tests. It would not seem to be logical to test a wheel with a large dish to the requirements of the radial fatigue tests and then also subject the same wheel to the less stringent requirements of either of the cornering tests. For passenger car wheels with small dishes, it may be possible to adopt the SAE tests if the questions on mounting, tolerances failure definitions and retorquing can be resolved. While mathematical means of equating tests can be derived, the mathematical conclusions must be supported by actual test evidence. For this reason, it would seem that additional testing to establish definite limits of dish and impressed load in the case of radial fatigue were in order. Using the cyclic moment from the 90° cornering test as a basis, and relating number of cycles through some form of the Weibull analysis, the approximate equivalent radial load can be determined. Testing would then have to be performed to establish the validity of the assumed correlation factor. Once established, the radial loads could be analyzed to determine if the resulting test had true life meaning.

by James E. Shearer
Compliance Testing, Inc., 1150 N. Freedom St., Ravenna, Ohio 44266
Contract DOT-HS-026-2-430
1976; 48p 1ref
Rept. for May 1972-Oct 1975.
Availability: NTIS

lap and shoulder) for the overall population, as well as for a variety of subsets (e.g. model year, impact site, crash type, vehicle weight, vehicle damage severity, and occupant age). The probability sample is of towaway accidents involving 1973-1975 model cars, collected by NHTSA-sponsored teams (as a part of the Restraint Systems Evaluation Program) from five geographic locations believed to provide national representativeness. Weighted sample size is 15,818 occupants; complete information is provided on belt usage, abbreviated injury scale (AIS) injury level, age, crash configuration, vehicle weight, and damage severity. Estimation of standardized injury rates and belt effectiveness measures is done by both the weighted least squares (GENCAT) estimation and the Mantel-Haenszel-type estimation, with a Taylor series expansion of the effectiveness measures. Estimation of belt effectiveness is also made using direct injury costs of Blue Cross Blue Shield. Both standardization methods generally lower the estimated injury rate for unrestrained occupants while fairly substantially raising the corresponding rates for the lap belted and lap and shoulder belted occupants. Some conclusions of the data analysis are that the lap and shoulder belt provides at least 10% more protection than the lap belt alone; that in subcompact cars, lap and shoulder belts but not lap-only belts are about as effective as in larger cars; that belt effectiveness does not necessarily decrease as crash severity increases; and that older people stand to benefit most from wearing seat belts. Appendices provide an occupant restraint system summary form, a codebook for extract file, contingency table screening analyses, contingency table analysis for compounded logarithmic-exponential-linear functions, the Mantel-Haenszel-type estimation, sensitivity analyses, empirical Bayes estimation, and estimation procedure for examining seat-belt effectiveness using direct injury cost.

by Donald W. Reinfurt; Claudio Z. Silva; Andrew F. Seila
University of North Carolina, Hwy. Safety Res. Center, Chapel Hill, N.C. 27514
Contract DOT-HS-5-01255
1976; 164p 28refs
Rept. for 1 July 1975-31 May 1976. For Vol. 2, Fact Book, see HS-802 036.
Availability: NTIS

HS-802 036

FACT BOOK: A SUMMARY OF INFORMATION ABOUT TOWAWAY ACCIDENTS INVOLVING 1973-1975 MODEL CARS. VOL. 2. FINAL REPORT

Data presented from a probability sample of towaway accidents involving 1973-1975 model cars collected by NHTSA-sponsored teams as part of the Restraint Systems Evaluation Program include the following: the occupant sample, the crash sample, injuries, seat-belt usage by the various subpopulations, occupant injuries and fatalities, malfunction, defeat, or maladjustment of belts; ejection; and problems encountered by unusual occupants. Weighted sample size is 15,818 occupants; sampling was done in five geographic areas believed to provide national representativeness. The occupant sample shows

represented in the daytime. The crash sample shows that males and younger people are overrepresented in rollover and front-impact site crashes. Other crash configurations concern relationships between model year, weight of vehicle, gender or age of driver, time of day, severity, impact site, and lighting conditions. With the exception of head-on collisions (in which older occupants are overrepresented), aggressive accidents are overrepresented in the 10-25 year age group. Analysis of injuries shows that as severity increases, so does cost of treatment; that treatment cost increases with the age of the vehicle; that there seems to be a classification of injuries related to vehicle weights; that certain vehicle makes have lower injury rates than others; and that side impacts cause the more severe injuries. Seat belt usage is not related to age or gender so much as to the role the occupant plays: drivers have a higher usage rate. There is a sudden increase in usage between 1973 and 1974 model cars, especially in shoulder-belt usage. Among the various relationships between usage and vehicle weight, usage increases from subcompact to full-sized vehicles. Type of road and area affects usage, e.g. the higher the usage the more lanes a road has. People tend not to use belts at night, especially after midnight; during the morning rush hour is the most common time to use belts. Usage decreases as accident severity increases. Belt effectiveness material given in vol. 1 is reviewed, and a formula given for calculating effectiveness from any table in vol. 2: percentage of injured with no belt usage minus percentage of injured using belt divided by percentage of injured with no belt usage. Belt-caused injuries are mainly contusions and pains in the hip, abdomen, and chest; they are less severe and costly than non-belt-caused injuries. Seat-belt problems include the potential for abuse by the user, and system defeat increases with increasing mileage. Of the various accident factors related to fatalities, time of day is the most significant: midnight to 6 a.m. is overrepresented. There is an overrepresentation also of side impacts in fatalities. Ejection data show the obvious benefit of belt usage. Data on unusual sizes of people show that while small people tend to be injured more often, it is with less severity, and that larger individuals are susceptible to malfunctions of the belts.

by Robert G. Hall
University of North Carolina, Hwy. Safety Res. Center,
Chapel Hill, N.C. 27514
Contract DOT-HS-5-01255
1976; 267p
Rept. for 1 Jul 1975-31 May 1976. For Vol. 1, see HS-802 035.
Availability: NTIS

HS-802 039

DEVELOPMENT OF A FRONT PASSENGER ASPIRATOR AIR BAG SYSTEM FOR SMALL CARS. FINAL REPORT

In the first year of a 24-month program an aspirator bag system for a standard size car was adapted to the crashworthy small car front seat passenger. Information is presented on the background leading to the restraint design, details of the restraint hardware, a discussion of the experimental tests conducted, and analysis of test results. Tabulated data are given With regard to specific design considerations of the aspirator system, several conclusions were drawn. Pressure records and high speed film data established that the system aspirated effectively (period of aspiration from 15 msec after inflator ignition till 80 msec after ignition for the static deployment tests). It was established that the air bag barely inflated with the aspirator flaps sealed but fully inflated to about 2.5 psig under conditions of full aspiration. With dual manifold geometry, nearly 2.5 psig bag pressure was produced versus less than 1.0 psig with single manifold. There was little effect of aspirator inlet area on bag pressure. Additional conclusions were drawn with respect to injury criteria. Tests with the aspirator air bag system produced data which satisfied injury criteria for the full range of adult dummy sizes through the 45 mph crash speed range. The system may be capable of providing protection from fatality or serious injury to adult front seat passengers in a similar small car environment up through an equivalent crash speed regime (conclusion based upon tests using anthropomorphic dummies under strictly one-dimensional crash pulse of the accelerator sled and intrusion not simulated). Based upon sled test results, it seems that the aspirated air bag system would provide a much safer crash environment to a small child than if the child were to be unrestrained. This holds for the child in the normal seated position, but it appears that the system can be made innocuous to the out-of-position child. It is recommended that the development and evaluation of this concept should be continued in the second phase of the program, that the evaluation should include a broader range of vehicle accident conditions and a greater data base, that consideration should be given to reducing space required and weight of the system, that the two driver gas generators in the system should be substituted with a cylindrical inflator which can be located within the aspirator housing, that as an alterative, the two driver gas generators could be substituted with a single generator similar in appearance to the standard driver unit but larger, and that the aspirator inlet area be reduced.

by David J. Romeo
Calspan Corp., 4455 Genesee St., Buffalo, N.Y. 14221
Contract DOT-HS-5-01254; Ref: DOT-HS-344-3-690
Rept. No. ZP-5777-V-1; 1976; 137p 16refs
Rept. for Jun 1975-Jul 1976.
Availability: NTIS

HS-802 040

STATIC EVALUATION OF AIR CUSHION DEPLOYMENT EFFECTS ON THE MEMORY RETENTION OF THE SOLID STATE DIGITAL RECORDER SYSTEM. FINAL REPORT

A static laboratory evaluation of the solid state recorder contained within the part 572 anthropomorphic dummy involving four air cushion inflation tests has been undertaken. This test series was intended to simulate the geometry of a 1975 Oldsmobile 88 right front passenger compartment. Voltages on and near the air cushion were also monitored during the inflation sequence and were determined to be on the order of a volt or less. On three of the tests conducted, the air cushion

made direct contact with the head of the dummy during inflation and triggered the recorder capturing the impact acceleration time histories. On one test, the dummy's recorder did not trigger, remaining in the ready mode. It did, however, trigger after the event when the dummy was subjected to a hammer blow on the head. The overall conclusion is that over the range of conditions tested no interaction between the air cushion inflation sequence and solid state recorders operation was observed.

Kaman Sciences Corp., 1500 Garden of the Gods Rd., Colorado Springs, Colo. 80907
Contract NHTSA-6-5377
Rept. No. K-76-64U(R); 1976; 30p 1ref
Rept. for Feb 1976-Jun 1976.
Availability: NTIS

HS-802 041

THE DRIVER EDUCATION EVALUATION PROGRAM (DEEP) STUDY0 SECOND REPORT TO CONGRESS

For young beginning drivers, all phases of the SPC (Safe Performance Curriculum), a model secondary school driver education curriculum, have been completed except the final demonstration phase which will be undertaken in 1976. Accident avoidance training has recently been incorporated into a number of young beginner driver education programs, e.g. the Accident Avoidance Skills Program, the results of the first two phases of which are available from the National Technical Information Service. Implementation should come in Fiscal Year 1979-80. The Parent Participation Program was pilot-tested in three schools, but the response was so limited that continuing research would have little validity. The project to develop an alcohol education curriculum with crash reduction potential is due for completion in June 1976 with plans for a demonstration project to follow. The Driver Responsibilities in the Seventies (DRIS) program is proceeding, with the records of two test groups to be monitored and compared for two years. Results from the State driver improvement program contract have been determined and distributed to the States. Two projects in motorcycle safety education are underway in cooperation with the Motorcycle Safety Foundation (MSF). The Improved Motorcycle Licensing and Testing Demonstration, unmentioned in the original Driver Education Evaluation Program (DEEP) report, seeks to demonstrate that more rigid testing of novice motorcyclists will result in lower accident rates, especially during the most hazardous first year. Upon completion, the program results will be distributed to the States. Planning stages for the Motorcyclist Education Project are underway, with pilot testing of student and instructor materials taking place during 1976. In conjunction with the Department of Health, Education, and Welfare (HEW) and the Veterans i Administration, a project for driver education and training for the handicapped will result in licensing guidelines for Division of Motor Vehicles (DMV) administrators and a plan for coordinated interagency R and D programs for driver education and licensing of the handicapped. For the future, NHTSA is supporting the new emphasis to make available comprehensive traffic safety education to a wide variety of driver groups, including vehicle occupants as well as drivers. In addition, an accident analysis project is being initiated to describe "model behaviors" in performance areas involved in crash causation. Finally, the diagnostic-remedial approach recommended in the 1975 Report to Congress is reflected in several projects underway, one of which developed an assessment model including a 23-item driver profile to differentiate the magnitude of problems for seven groups based on age and sex. This will guide further diagnosis, rehabilitation, and penalty measures. With input from many organizations and citizens, driver education standards are being revised to reflect increased emphasis on scientific program evaluation, rather than on program expansion. A bibliography is included along with a summary of the findings of the First Annual Report to the Congress on DEEP.

National Hwy. Traffic Safety Administration, Washington, D.C. 20590
1976; 28p 11refs
Availability: NHTSA

HS-802 042

PROGRAM LEVEL EVALUATION OF ASAP 0ALCOHOL SAFETY ACTION PROJECT0 DIAGNOSIS, REFERRAL AND REHABILITATION EFFORTS. VOL. 1--DESCRIPTION OF ASAP DIAGNOSIS, REFERRAL AND REHABILITATION FUNCTIONS. FINAL REPORT

The organization and operational characteristics of the 35 NHTSA Alcohol Safety Action Projects (ASAP's) are described and summarized. The initial plan for the ASAP (Highway Safety Act, 1970) called for at least one project in each of the 50 states; however, this number was modified to limit the total to 35. The ASAP's reflect the adaptation, to local conditions and to local driver control systems, of a broad system of alcohol countermeasures which include enforcement, judicial, licensing, diagnosis/referral, and rehabilitation activities. NHTSA guidance in the design of individual ASAP countermeasure systems is provided by the Handbook for Directors of ASAP's which was produced under a contract between NHTSA and the Human Resources Research Organization. At the program level it was anticipated that diagnosis, and referral and rehabilitation countermeasure functions would be employed as a supplement to, rather than as a substitute for, existing driver control mechanisms which involve the treatment of A/R traffic offenders by enforcement, judicial and licensing agencies at each site. ASAP's are located in the following areas: Albuquerque, N. Mex.; Charlotte/Mecklenburg Co., N.C.; Denver, Colo.; Marathon and Sheboygan Co., Wis.; Nassau Co., N.Y.; Portland, Oreg.; Seattle, Wash.; Washtenaw Co., Mich.; Vermont; Baltimore, Md.; Boston, Mass.; Cincinnati, Ohio; Columbus, Ga.; Fairfax Co., Va.; Hennepin Co., Minn.; Indianapolis, Ind.; Kansas City, Mo.; Lincoln, Nebr.; Little Rock/Pulaski Co., Ark.; New Hampshire; New Orleans, La.; Oklahoma City, Okla.; Phoenix, Ariz.; Portland/Cumberland-York, Maine; Richland Co., S.C.; San Antonio, Tex.; South Dakota; Tampa, Fla., Wichita, Kans.; Delaware; Idaho; Los Angeles, Calif.; Puerto Rico; Sioux City/Woodbury Co., Iowa; and Utah. The characteristics of the diagnosis/referral/rehabilitation activities at each project are summarized using the following categories: judical mechanisms, diagnostic procedures, rehabilitation referral procedures, and rehabilitation modalities. Available information is reviewed and a project description for each ASAP is presented. Tabulated data include alcohol safety action projects fiscal year funded, judicial mechanisms, diagnostic procedures, position of background investigation in the operational sequence, procedures for referral to rehabilitation, general types of rehabilitation modalities available at each

AP, and facilities and related programs by NIAAA-sponed alcoholism centers.

Timothy J. Springer
iversity of South Dakota, Human Factors Lab., Vermillion, Dak. 57069
ntract DOT-HS-191-3-759
'6; 237p 13refs
pt. for Jul 1973-Jun 1976; for vols. 2-4 respectively, see HS-! 043--HS-802 045.
ailability: NTIS

-802 043

OGRAM LEVEL EVALUATION OF ASAP .LCOHOL SAFETY ACTION PROJECT0 AGNOSIS, REFERRAL AND REHABILITATION FORTS. VOL. 2--ANALYSIS OF ASAP DIAGNOSIS ND REFERRAL ACTIVITY. FINAL REPORT

alyses of the diagnosis and referral systems of the 35 HTSA Alcohol Safety Action Projects (ASAP's) for the riod 1972 to 1974 are presented. ASAP's are located in the llowing areas: Albuquerque, N. Mex.; Char-te/Mecklenburg Co., N.C.; Denver, Colo.; Marathon and eboygan Co., Wis.; Nassau Co., N.Y.; Portland, Oreg.; attle, Wash.; Washtenaw Co., Mich.; Vermont; Baltimore, d.; Boston, Mass.; Cincinnati, Ohio; Columbus, Ga.; Fairfax ., Va.; Hennepin Co., Minn.; Indianapolis, Ind.; Kansas ty, Mo.; Lincoln, Nebr.; Little Rock/Pulaski Co., Ark.; New ampshire; New Orleans, La.; Oklahoma City, Okla.; ioenix, Ariz.; Portland/Cumberland-York, Maine; Richland ., S.C.; San Antonio, Tex.; South Dakota; Tampa, Fla.; 'ichita, Kans.; Delaware; Idaho; Los Angeles, Calif.; Puerto ico; Sioux City/Woodbury Co., Iowa; and Utah. A descrip-on of the subsystems as they operated at the 35 ASAP's is esented along with client flow data. Profiles of clients in rinker diagnosis categories and several rehabilitation modality tegories are presented for demographic and arrest history ariables. Analyses designed to assess the validity of several pes of diagnostic systems employed by the ASAP's are esented. Results of these analyses indicate that NHTSA iteria for drinker diagnosis are the most valid of the systems alyzed. Analyses concerning the validity of standardized iagnostic tests utilized in the ASAP diagnostic procedures are resented. The results of the analyses support only the use of ie Mortimer-Filkins Questionnaire and Interview together. he Mortimer-Filkins Questionnaire alone was found to have ss predictive validity than the Interview and Questionnaire gether. Statistical data are included.

y David L. Struckman-Johnson; Edward F. Mushill
niversity of South Dakota, Human Factors Lab., Vermillion, . Dak. 57069
ontract DOT-HS-191-3-759
976; 247p 19refs
ept. for Jul 1973-Jun 1976; for vols. 1, 3, and 4 respectively, ee HS-802 042, HS-802 044 and HS-802 045.
vailability: NTIS

HS-802 044

ROGRAM LEVEL EVALUATION OF ASAP)ALCOHOL SAFETY ACTION PROJECT0 DIAGNOSIS, REFERRAL AND REHABILITATION EFFORTS. VOL. 3--ANALYSIS OF ASAP REHABILITATION COUNTERMEASURES EFFECTIVENESS. FINAL REPORT

Client flow through rehabilitation systems of the 35 NHTSA Alcohol Safety Action Projects (ASAP's) during the 1972-1974 period of project operations is described along with summaries of project initiated analyses of treatment program effectiveness, program level (across project) analyses of total treatment system and individual treatment modality effectiveness based upon rearrest recidivism (for alcohol related offenses) data reported by the projects. ASAP's are located in the following areas: Albuquerque, N. Mex.; Charlotte/Mecklenburg Co., N.C.; Denver, Colo.; Marathon and Sheboygan Co., Wis.; Nassau Co., N.Y.; Portland, Oreg.; Seattle, Wash.; Washtenaw Co., Mich.; Vermont; Baltimore, Md.; Boston, Mass.; Cincinnati, Ohio; Columbus, Ga.; Fairfax Co., Va.; Hennepin Co., Minn.; Indianapolis, Ind.; Kansas City, Mo.; Lincoln, Nebr.; Little Rock/Pulaski Co., Ark.; New Hampshire; New Orleans, La.; Oklahoma City, Okla.; Phoenix, Ariz.; Portland/Cumberland-York, Maine; Richland Co., S.C.; San Antonio, Tex.; South Dakota; Tampa, Fla.; Wichita, Kans.; Delaware; Idaho; Los Angeles, Calif.; Puerto Rico; Sioux City/Woodbury Co., Iowa; and Utah. During the 1972-1974 period, a total of 140,540 court referred clients were exposed to a variety of ASAP supported or coordinated rehabilitation programs, at a cost to the ASAP's of $5,346,502. The most extensively used treatment alternatives were ASAP-initiated alcohol safety schools, although substantial use was also made of community alcohol rehabilitation resources. Evaluation of ASAP rehabilitation effectiveness was hampered, at both program and project levels, by a lack of adequate experimental designs which provided no-treatment groups whose performance could be compared to that of treatment groups. Some indications of program effectiveness were found, particularly for problem drinkers. Numerous tables give statistical data.

by Vernon S. Ellingstad; Timothy J. Springer
University of South Dakota, Human Factors Lab., Vermillion, S. Dak. 57069
Contract DOT-HS-191-3-759
1976; 177p 19refs
Rept. for Jul 1973-Jun 1976. For vols. 1, 2, and 4 respectively, see HS-802 042, HS-802 043 and HS-802 045.
Availability: NTIS

HS-802 045

PROGRAM LEVEL EVALUATION OF ASAP 0ALCOHOL SAFETY ACTION PROJECT0 DIAGNOSIS, REFERRAL AND REHABILITATION EFFORTS. VOL. 4--DEVELOPMENT OF THE SHORT TERM REHABILITATION (STR) STUDY. FINAL REPORT

The development, implementation, and current status of a Short Term Rehabilitation (STR) study initiated by the NHTSA in 1974 at 11 of its ASAP (Alcohol Safety Action Project) sites are discussed. The ASAP sites selected were Denver, Colo.; Fairfax Co., Va.; Kansas City, Mo.; Hennepin Co., Minn.; New Orleans, La.; Phoenix, Ariz.; San Antonio, Tex.; South Dakota; New Hampshire; Oklahoma City, Okla.; and Tampa, Fla. Experimental designs employed by each of the sites for the assignment of mid-range problem drinker drivers to STR treatment or control groups are described. Preliminary efforts to consolidate the individual site designs into a set of program level designs are also discussed. The

STR data system which incorporates initial client intake data as well as 6-, 12-, and 18-month client follow-up interview and record data is also described. Appendices contain sample questionnaires used by client and interviewer, STR workshop agenda, and tabulated statistical data. Preliminary analyses designed to provide a set of life change criteria for use in assessing the effectiveness of STR rehabilitation modalities are presented. These analyses have been applied to the Life Activities Interview to yield five life status factors including the following: Alcohol Use, Income/Employment, Socialization/Social Activity, Family/Marital Status, and Physical Health Factors. Scales of the Current Status Questionnaire (CSQ) and Personality Assessment Survey (PAS) instruments are also presented.

by Vernon S. Ellingstad
University of South Dakota, Human Factors Lab., Vermillion, S. Dak. 57069
Contract DOT-HS-191-3-759
1976; 242p 14refs
Rept. for Jul 1973-Jun 1976. For vols. 1-3 respectively, see HS-802 042--HS-802 044.
Availability: NTIS

HS-802 046

RESEARCH SAFETY VEHICLE (RSV), PHASE 2. SEVENTH STATUS REPORT

Calspan's work to date on development of a research safety vehicle (RSV) has focused on mock-up and display material, the crash car build program, and the restraint system. Achievements in design engineering include analysis of front structure crush test data and side structural crush data, performance of car-to-car computer simulations, choice of aluminum honeycomb as the best energy-absorbing door trim panel, continued study of the inflatable belt concept, continued study on packaging of the 1716 cc engine, study of the indirect visibility, work on antiskid braking, and continued repairability investigation. Testing included the following: the third sled test series; completion of static crush testing of RSV structures; a full-scale crash test of the front seat restraint system; braking testing; and planning for system integration tests. An RSV costing effort was begun, material/weight characteristics have been developed, and recyclability shredding experiments were conducted on aluminum/steel hoods and on a base car. RSV specifications are being compared with RSV test data. Final test plan recommendations have been submitted. Attached are the RSV weight report, results of updated car-to-car collision compatibility study, and the RSV chassis specification document.

Calspan Corp., Buffalo, N.Y. 14221
Contract DOT-HS-5-01214
1976?; 170p
Rept. for 16 Jul-15 Sep 1976.
Availability: Reference copy only

HS-802 048

REPORT ON ADMINISTRATIVE ADJUDICATION OF TRAFFIC INFRACTIONS. HIGHWAY SAFETY ACT OF 1973 (SECTION 222)

With the exception of the New York Administrative Adjudication Program (NYAAP) and the Seattle and Rhode Island projects, jurisdictions do not have traffic infraction adjudication systems strongly oriented to highway safety as established by research. A detailed program manual has been developed by the Justice Department's Law Enforcement Assistance Administration (LEAA) with the assistance of NHTSA to serve as a guide to jurisdictions considering changes in traffic infraction adjudication. Currently, NHTSA is conducting comparative field research on the fairness, efficiency, and effectiveness of NYAAP as compared to traditional traffic case processing in that state. A national survey is being conducted to determine the status of driver-licensing-agency-hearing authority. An analysis has been made of all state laws that have decriminalized the bulk of the moving rule-of-the-road violations to infractions. A review and updating of the status of administrative adjudication in the states is presented. Findings of the report period are categorized in the following manner: review of traffic adjudication approaches; assessment of feasibility of administrative adjudication of traffic infractions; Department of Transportation Demonstration and Research Projects, Seattle Special Adjudication for Enforcement (SAFE), Rhode Island SAFE, state driver-licensing-agency-hearing authority, and alcohol safety action project experience; and receptivity of jurisdictions to administrative adjudication of traffic infractions. Some recommended changes would provide for: jurisdictions that have decriminalized moving rule-of-the-road violations as infractions to inquire into the potential advantages and benefits offered by administrative adjudication and noncriminal traffic infraction case processing; the institution of civil case procedural and evidential techniques in order to achieve the full development of efficient and safety effective traffic infraction case processing; jurisdictions to begin to pay increased attention to licensing agency conformance with due process hearing requirements in traffic safety cases; and driver-licensing-agency-hearing-officer training including standards relating to due process hearing requirements as marked out by recent Federal and state court determinations. A glossary of acronyms used in the report is appended.

National Hwy. Traffic Safety Administration, Washington, D.C. 20590
1976; 19p
Availability: NHTSA

HS-802 049

UNITED STATES EVALUATION REPORT ON CCMS 0COMMITTEE ON THE CHALLENGES OF MODERN SOCIETY0 ROAD SAFETY PILOT STUDY FOLLOW-UP

In this final in a series of reports by various nations submitted to the NATO Committee on the Challenges of Modern Society (CCMS) covering the Committee's Road Safety Pilot Study as well as follow-up and implementation of Study recommendations, the U.S. (the pilot country) evaluates the progress made in relation to the overall cooperative follow-up on the Study and its associated resolutions. The "United States National Report on CCMS Road Safety Pilot Study Follow-up" was submitted to CCMS in June 1975 and subsequently distributed to all NATO CCMS governments (Belgium, Canada, Federal Republic of Germany, France, The Netherlands, Italy, and United Kingdom) and to the European Conference of Ministers of Transport (ECMT), Road Safety Committee. The U.S. National Report documented follow-up agreements and overall progress up to that time by the U.S. and other participating nations. The evaluation report presented here is based on the assumption that the recipients are generally

familiar with the contents of the U.S. National Report. Included in this report are brief discussions of the CCMS International Resolution on Road Safety for NATO nations (adopted in 1973 by CCMS) and progress made in satisfying this resolution, the program exchange among nations, the Ad Hoc Group to coordinate all road safety follow-up activity, and an update and evaluation of follow-up for each of the seven pilot study projects. The Road Safety Pilot Study has been a model pilot study from conception through initiation, completion and follow-up as originally planned and envisioned by NATO's approach to the Challenges of Modern Society. The efforts, recommendations, and extensive momentum have been transferred effectively to the ECMT Road Safety Committee, OECD (Organization for Economic Cooperation and Development), and C.I.T.A. (Comite Internationale de l'Inspection Technique Automobile). The U.S., through the Department of Transportation and NHTSA, will continue to be responsible for follow-up on the Experimental Safety Vehicles project. It is suggested that the Spring 1976 Plenary Meeting of the CCMS, with the adoption of the two remaining implementing resolutions, i.e., Pedestrian Safety and Identification and Correction of Road Hazards, is the appropriate point at which to recognize the effort as completed and to terminate formally the Road Safety Pilot Study follow-up. The main part of the report is appended and contains national reports on follow-up from Belgium (French text), Canada, West Germany, France (French text), the United Kingdom, and the United States, and sections on the ECMT Report on Accident and Casualties--Year 1974, Road Safety Program Personnel, Ad Hoc Group Recommendations, Implementing Resolution on Pedestrian Safety, Implementing Resolution on Road Hazards, and Follow-up Status and Evaluation Summary.

NATO, Committee on the Challenges of Modern Society, 1110 Bruxelles, Brussels, Belgium
Rept. No. CCMS-44 ; 1976; 180p 94refs
Availability: NHTSA

HS-802 050

RESEARCH SAFETY VEHICLE (RSV), PHASE 2. FIFTH STATUS REPORT

Calspan's work to date on development of a research safety vehicle (RSV) has focused on the preliminary design review, which is now considered complete. Achievements in design engineering include studies on the candidate engines (1442 cc, 1716 cc, and 1984 cc), completion of the pedestrian impact simulation, preparation of design alteration proposals following the first forward structure static crush test, development of a NASTRAN model of the RSV structure, continuing work on the inner door panel, extensive work on the restraint system, completion of RSV styling, and continuation of the vehicle build program. Testing included the following: the first static crush tests; dynamic impact tests of the soft bumper; about 20 sled runs; a complete series of vehicle dynamics tests on the base vehicle; and drop tests on an idealized door trim panel. As for producibility, a memorandum of material availability/usage forecast was issued and a cost analysis of RSV modifications initiated. No changes in the RSV specifications have yet been proposed. A draft of the Phase 4 Test Plan is in preparation. Attached are a report of RSV base vehicle serviceability, results of car-to-car collision models compared with crash test data, and the RSV weight report.

Calspan Corp., Buffalo, N.Y. 14221
Contract DOT-HS-5-01214
1976?; 174p
Rept. for 16 Mar-15 May 1976.
Availability: Reference copy only

HS-802 051

A MANUAL OF MODEL POLICE TRAFFIC SERVICES, POLICIES, PROCEDURES, RULES. PHASE 3. MODEL POLICE TRAFFIC SERVICES RULES

Model police traffic services rules are presented which deal with the following: conformance to law and actions that induce, impinge, or border on illegal activity (e.g., use of force, arrest and detention, search and seizure, influence of or to official action, vehicle operation, misappropriation of property); efficient and appropriate attention to and performance of, assigned duties and responsibilities (e.g., attendance, selective enforcement, report preparation); reasonable and appropriate use of authority and discretion, including objectivity and emergencies; professional police conduct, including court and hearing demeanor; care and use of departmental vehicles and other property; and administrative requirements for effective operations (e.g., obedience, security, and news media relations). A suggested method of coding policies, procedures, and rules provides information on identification, effective date, number, subject, reference, special instructions, distribution, and reevaluation. Discipline ought to be seen as a matter of instruction rather than punishment, and as such must be based on rules valid for a rapidly changing society with a clear, organized dissemination of them: discipline is a part of management. To structure a disciplinary system properly, the following are necessary and are discussed at length: delineation of organizational goals and objectives; establishment of a written directives system, including training bulletins; and establishment of responsibility for discipline, delegation of authority, and methods of control. An example is presented of a model police disciplinary order of complaint, disciplinary, and summary punishment procedures. A valid disciplinary process must provide for establishment of standards and rules, and of a system for detection and reporting of rule violations, reporting procedures for violations or misconduct, assignment of responsibility for complaint handling, provision for temporary or emergency suspensions, investigation, charging, hearing, imposition of sanctions, and the appeal process. Appendixed to this publication are training bulletins in the areas of court appearances, fatal vehicle accidents, and pedestrian accidents.

International Assoc. of Chiefs of Police, Inc., Police Management and Operations Divisions
Contract DOT-HS-036-3-712
1976; 193p 5refs
Cover title, "A Manual of Police Traffic Services Rules."
Availability: Department of Transportation, National Highway Traffic Safety Administration, Washington, D.C. 20590

HS-802 054

REVIEW OF METHODS FOR STUDYING PRE-CRASH FACTORS. FINAL REPORT

A study of the pioneering methodology in analyzing pre-crash factors urges that the results of such work be taken as instructive rather than conclusive when applying them to the development of highway safety countermeasures. Critiques are made of work done by the University of Indiana Institute for Research in Public Safety, Cornell Aeronautical Laboratory, Inc. (now Calspan Corp.), Operations Research, Inc., and the University of Miami in various areas of accident causation: multidisciplinary highway crash investigation; vehicle defects as related to failures and crashes; driver response during emergencies; the process of accident generation; vehicle injury sources; pedestrians; single-vehicle accident model; investigation methods; and data gathering. Recommendations include the following: continue police-level data collection substantially as is; gather more in-depth data on trucks, motorcycles, bicycles, and minor accidents; implement the National Accident Sampling System (NASS), remembering to keep design flexible to allow for future innovations and to include all levels of crashes and all vehicle types; sponsor a major accident causation study; do short-term studies on data needs, existence of required data, alternative approaches to data collection, development of appropriate quantifiers, exposure requirements, statistical methodology, determination of countermeasures effectiveness, and information retrieval.

by Frank Haight; Hans Joksch; James O'Day; Patricia Waller; J. Stutts; D. Reinfurt
University of North Carolina, Hwy. Safety Res. Center, Chapel Hill, N.C. 27514
Contract DOT-HS-4-00897
1976; 105p 34refs
Rept. for Oct 1975-May 1976.
Availability: NTIS

HS-802 055

SHORT-TERM REHABILITATION FOR PERSONS CONVICTED OF DRIVING WHILE INTOXICATED. FINAL REPORT

The objectives of the project were to develop a classification system for assessing persons convicted of driving while intoxicated (DWI's), identify short-term rehabilitation (STR) objectives for these people, review available treatment programs, and make recommendations of programs which can be used to help DWI's reach STR objectives. A classification system was designed which included assessment of the client's adaptability to inner conflict/stress, assessment of the forces affecting the client regarding drinking from his sociocultural environment, and the severity of the client's problem with alcohol. Using the classification system, a set of STR objectives is identified for a client which represents desirable changes in the client's behavior and the impact of his sociocultural environment: socialize the client, decrease his vulnerability, expose him to different norms and values concerning drinking, increase his knowledge about alcohol use and abuse, help him decide between responsible drinking and abstinence, help him to recognize what triggers excessive drinking, teach him skills in choosing alternatives, help him change his responses to stress, build up his skills in alternatives to alcohol abuse, aid him in blocking or inhibiting his pattern of inner stress, get him to admit his severe drinking problem, and get him to commit himself to seeking help from available resources. STR programs are recommended and presented which include some elements of treatment modalities which have been proven effective. They include a behaviorally-oriented program, individualized behavior therapy, integrated behavior change, a community-reinforcement approach, and power motivation training. Brief course and workshop materials are presented in appendices.

by Richard E. Boyatzis
McBer and Co., 137 Newbury St., Boston, Mass. 02116
Contract DOT-HS-5-01253
Rept. No. MC-FR-311; 1976; 231p 229refs
Rept. for Jul 1975-Apr 1976.
Availability: NTIS

HS-802 061

RSV 0RESEARCH SAFETY VEHICLE0 PHASE 2-- BI-MONTHLY PROGRESS REPORT, JULY 17, 1976 TO SEPTEMBER 16,1976 (SMALL-CAR CRASH TESTING)

In a report to DOT on small-car crash studies conducted by Minicars, Inc., contract expenditures, revision of planned testing and test article fabrication activities, specifics of test mode, equipment design and evaluation, and enumeration and evaluation of tests performed are discussed. A projected overrun has been avoided by a reduction in staff, tests, and test-article fabrication. Disagreement over the specifications of some side-impact tests have been resolved. Difficulties with the cable gripping/towing/disengagement mechanism continue. The interior/exterior mockup was completed and delivered. Tests conducted include oblique side impact, damageability, 40 mph rear-end, and offset barrier. Appendices contain details of schedule for remaining tests, correspondence, and a stop work order to a company making modified parts for test articles, correspondence to DOT contracting officer, and a summary of recent crash test results.

Minicars, Inc., 35 La Patera Lane, Goleta, Calif. 93017
Contract DOT-HS-5-01215
1976; 22p
Availability: Reference copy only
1976; 79p 2refs
Rept. for Feb 1976-Jul 1976.
Availability: NTIS

HS-802 063

NATIONAL ACCIDENT SAMPLING SYSTEM. SELECTION OF PRIMARY SAMPLING UNITS

The primary sampling unit (PSU) sampling plan that was devised by the National Accident Sampling System (NASS) staff and its application to select the first ten PSU's for NASS implementation are described. The National Highway Traffic Safety Administration's National Accident Sampling System will result in the investigation of a multistage stratified cluster sample of traffic accidents occurring within the 48 contiguous States. The PSU's are individual or groups of counties and towns. The PSU selection scheme is similar to the one used in the U.S. Census Bureau's Current Population Survey as follows: stratification of nonself-representing PSU's with one selection per stratum, sampling with probability proportional to size, controlled selection by geographical region, and use of the Keyfitz scheme on selections subsequent to the initial one. The ten initial PSU sites were selected using population as a measure of size and urbanization and service station sales as

ratification criteria. The initial sites are as follows: region
ie-iNew England, New York (except New York City and
ong Island), Newark city; region two--New Jersey (except
ewark City), New York City and Long Island, Philadelphia,
ontgomery, Delaware and Bucks Cos., Pennsylvania; region
ree-- Pennsylvania (except counties listed above), Delaware,
aryland, District of Columbia, Virginia, West Virginia, An-
rson, Blount, Knox, and Union Cos., Tennessee; region
ur--North Carolina, South Carolina, Georgia, Florida,
arion, sequatchie, and Hamilton Cos., Tennessee, Russell
)., Alabama; region five--East South Central States (except
unties in Tennessee and Alabama listed above), Indiana
xcept Lake, Porter, Allen, St. Joseph, and Marshall Cos.),
issouri (except St. Louis city), New Orleans city; region six-
/est Central States (except New Orleans city), New Mexico;
gion seven--Michigan, Ohio, Allen and St. Joseph Cos., Indi-
a; region eight--Illinois, Wisconsin, Minnesota, Lake,
rter, and Marshall Cos., Indiana, St. Louis city; region nine-
/est North Central States (except Minnesota and Missouri),
ountain States (except New Mexico), Washington, Oregon;
gion ten--California.

Charles J. Kahane
ational Hwy. Traffic Safety Administration, Office of
atistics and Analysis, Washington, D.C. 20590
pt. No. NHTSA-TN-N43-31-8 ; 1976; 19p 5refs
/ailability: NHTSA

S-802 064

JMMARY OF FIELD EXPERIENCE INVOLVING
IR-BAG EQUIPPED CARS

ie history of field accident experience with air bags or air
shion restraint systems (ACRS) began in late 1972 when the
rd Motor Company and Eaton Corporation collaborated to
ace in service approximately 800 air-bag equipped Mercury
ssenger cars. Shortly thereafter, the General Motors Cor-
ration placed in service approximately 1,000 air-bag
uipped full-size Chevrolet cars. In January 1974, General
otors began offering the air bag as an option on full-size
tick, Cadillac, and Oldsmobile cars. The AB Volvo Corpora-
n placed 75 air-bag equipped 1975 model 244 sedans into
ee private fleets beginning in January 1975. The data collec-
n system established in January 1974 by NHTSA to collect
formation on air-bag equipped cars in accidents included
tification to owners, GM service personnel, and police of a
porting network operated by the DOT's National Response
nter on a 24-hour basis. The data presented here include a
t of the number of air-bag cars manufactured, a list of
ferences providing other details on the field experience and
evaluation, and tables containing information on deploy-
nt accidents, nondeployment accidents, nondeployment ac-
lents involving moderate or greater injury, and inadvertent
d noncollision deployments.

ational Hwy. Traffic Safety Administration, Office of
atistics and Analysis, Washington, D.C. 20590
76; 27p 4refs
/ailability: Reference copy only

HS-802 065

EXECUTIVE SUMMARY OF ACRS 0AIR CUSHION RESTRAINT SYSTEMS0 VEHICLE DEPLOYMENTS

A summary of ACRS (Air Cushion Restraint Systems) vehicle deployments as of 31 Aug 1976 shows that there have been 110 accidents with air bag deployment and 8 nonaccident deployments. Seventy-two of the deployment accidents have occurred in the 1974-1975 General Motors cars (8,990 sold as of 30 April 1976), 12 occurred in the 1972 Mercury fleet (831 cars built), 25 in the 1973 Chevrolet fleet (1,000 cars built), and one in the 1975 Volvo fleet (75 cars built). The date and location, type of collision, description of conditions surrounding accident, and injury to passengers are given for the individual incidents involving ACRS deployment.

National Hwy. Traffic Safety Administration, Office of Statistics and Analysis, Washington, D.C. 20590
1976; 78p
Availability: Reference copy only

HS-802 067

STATIC BRAKE INSPECTION INVESTIGATION. VOL. 1. FINAL SUMMARY REPORT

A set of inspection criteria and techniques were developed for the conduct of static (non performance) brake inspections for passenger vehicles and light trucks without removing wheels. The Static Brake Inspection System was based on a survey of the state-of-the-art of existing systems, criteria and techniques, as well as a thorough literature search. The basic performance objectives of a static brake inspection system were determined based on trade-off studies of inspection items and available inspection methods. The most promising approaches were evaluated and a preliminary system was generated. Because of the need to make use of common vehicle modifications, a dialogue with auto manufacturers was established and the inspection system was carefully re-examined from the point of view of cost, producibility and lead time required for incorporation into production vehicles. Based on this research, a final specification for a Static Brake Inspection System and the procedure for carrying out static inspections in a cost effective manner were defined. The highlights of the proposed inspection system include: no wheel removal, no expensive technology, inspection from under the car from the inside out, the "referee tool" concept (tools to be defined and standardized), and recommendation of a 3,000 miles lining standard (remaining mileage rather than specific thickness). The program resulted in a recommended final specification of vehicle modification, inspection tools, reject criteria and procedure. Among the vehicle modifications are indicators for pad, drum, rotor and lining wear, wheel cylinder leak indicator/diverter (for drum brakes), hub seal diverter/indicator, master cylinder fluid level indicator and external leak diverter/indicator, and access ports for visual inspection with light source and mirror. A further specification is for a proof test load of 200 lbs. applied to the brake pedal for 10 seconds reacted through the driver's seat. The system was demonstrated with three typical modified vehicles and with demonstration models.

by A. White
Avco Systems Div., 201 Lowell St., Wilmington, Mass. 01887
Contract DOT-HS-4-00949
1976; 35p
Rept. for Jul 1974-Jun 1976. Vol. 2 is detailed description of program activities; Vol. 3 contains technical appendixes.

HS-802 075

PEDESTRIAN SAFETY. PROGRAM MEMORANDUM

NHTSA developed a systematic approach to the collection, analysis and interpretation of pedestrian accident data for use throughout the country. It provides a framework for identifying: major aspects of the pedestrian accident process; methods of grouping these different aspects in order to understand accidents with common causal patterns; and the ways in which these patterns may be reviewed to identify possible countermeasures. The conditions that influence these functions are factors of the driver, pedestrian, vehicle and environment. NHTSA has classified pedestrian accidents into 30 categories, 60% falling into the following: dartout, intersection dash, vehicle turn/merge--with attention conflict, multiple threat, bus stop related, vendor--ice cream truck, and backing up. Currently NHTSA is conducting research on a number of promising countermeasures directed at identified pedestrian accident types, including kindergarten through third grade pedestrian education programs, pedestrian safety messages, and the development of model pedestrian safety regulations for selected accident types. Problem definition and analysis of rural pedestrian accidents is being determined and countermeasure programs will be developed. Local input is being encouraged to meet local pedestrian safety problems, with emphasis on some national uniformity of vehicle operators crossing various jurisdictions. NHTSA recommends that in administration, a single State agency have primary authority and responsibility for pedestrian safety. In Legislation, laws and ordinances regulating pedestrian safety should be in reasonable conformity with the Uniform Vehicle Code and Model Traffic Ordinance. In engineering, FHWA's Highway Safety Program Standards should provide guidance in engineering practices regarding construction of pedestrian ways, and such ways should be required at all construction and demolition sites; pedestrian accident data must provide a reasonably accurate assessment of the size of the local pedestrian accident types through increased uniformity of collection methods and in reasonable conformity with national standards; program development and implementation should be considered for all ages in all possible areas; and an evaluation plan and methodology should be determined by each State to determine the number and type of pedestrian accidents and measure public awareness of the need for pedestrian safety.

National Hwy. Traffic Safety Administration, Traffic Safety Programs, Washington, D.C. 20590
1976; 10p
Availability: NHTSA

HS-802 078

REPORT OF THE EVALUATIVE COPY TEST OF A NEW NHTSA COMMERCIAL "SLEEPING MAN": 60. FINAL REPORT

In order to make an opinion survey of a new TV spot concerning drunk driving, ARS (Alcohol Related Situations) qualified people were recruited at central locations in three metropolitan areas on the pretext that they would be evaluating the content of a 10-min segment of a proposed new TV program. This film contained the test commercials plus 1.5 minutes of distractive commercials. After exposure to the program on a rear screen projector (simulating a TV screen), respondents were immediately questioned on the show, the commercials in general and "Sleeping Man" in particular. A total of 149 interviews was conducted in three geographically dispersed metropolitan areas: New York (50), Chicago (51) Los Angeles (48). Respondents were qualified on the basis that they were between 18 and 55 years of age, and they participated in alcohol-related situations at least once a month. Interviewing was conducted Apr 21-26, 1976. Although somewhat less impactful than "Teddy" (which tested exceptionally well) "Sleeping Man" proves to be quite effective in its ability to communicate its main copy objective, prevention of drunk driving; persuade on overall countermeasure action and on specific countermeasures, "call a taxi," or "suggest drive drunk home;" generate acceptable levels of probed "likes", probed "dislikes", and relevant diagnostic rates. Suggestions are that in view of its demonstrated ability to persuade on "calling a taxi" and "suggest drive drunk home", "Sleeping Man" would work well with "Teddy" whose strength lies in the area of education on myths. Therefore, efforts should be made to have "Sleeping Man" aired in conjunction with "Teddy" and not as a replacement since each complements the other so well. Appendices are included on personal drinking behavior of the ARS sample; demographic characteristics; portrayal of the film spot; and a sample questionnaire from the survey.

Grey Advertising Inc., 777 Third Ave., New York, N.Y. 10017
Contract DOT-HS-5-01256
Rept. No. 10400603BF ; 1976; 41p
Availability: NTIS

HS-802 097

RULES OF THE ROAD RATED

An annual rating of state traffic laws to show how they compare with the rules of the road part of the Uniform Vehicle Code as of 1 Jan 1976 is presented. The rating covers 1975 state traffic laws but does not include changes adopted by state legislatures in 1976. An attempt has been made to provide a more precise picture of the status of state traffic laws that will facilitate rapid identification of particular areas of a state's laws that may not be in substantial conformity with the Code, indicate areas of the statutory law where uniformity may be markedly poor on a nationwide basis, and identify states whose traffic laws may need substantial attention on a priority basis as part of contemporary efforts to improve highway safety. State laws were rated in comparison with the Uniform Vehicle Code and were assigned a number, individual numbers representing a varying degree of conformity with the Code. These numerical designations have been arranged in tabular form, there being 13 tables--one for each article in the rules of the road part of the Code. The total points for each state in these 13 tables form the basis for an additional table. Another table ranks the states according to total points and shows an increase or decrease in points between 1974 and 1975. A brief overall view of 1975 changes in state traffic laws is presented. It is pointed out that the rating system and its application are not perfect, and the inequities are discussed.

by Edward F. Kearney
National Com. on Uniform Traffic Laws and Ordinances, 1776 Massachusetts Ave. N.W., Washington, D.C. 20036
Contract DOT-HS-5-01121
Publ: Traffic Laws Commentary v5 n1 32p (Sep 1976)
1976; 11refs
Availability: GPO $.85, Stock No. 050-003-00231-3

drinking and driving, use of alcoholic beverages, and awareness of drinking-driving media campaigns. Of the survey participants, 39% were male; 55% were thirty-five or older; and 64% were married. Drunk driving was selected as an extremely important problem by 58% of the survey sample. This compares with 49% for both crime and drug abuse. A majority believe that a can of beer is not less intoxicating than a shot of liquor, and that coffee will not help to sober a person up. A majority also strongly agreed that a person should stop a friend or relative from driving when drunk, even if it involves taking physical action. However, when presented with several possible responses in a drinking-driving situation, they indicated that they were much more likely to suggest a ride home or a night's rest for the intoxicated friend or relative than they were to take away his car keys or to use physical restraint. Thirty-seven percent reported that they had discussed drinking and driving in the past month, and 35% reported that during the past year they had been in the situation where someone had been drinking too heavily and was about to drive a car. Of those who reported being in such a situation, 75% reported they had taken action to stop the drunk person from driving. Also, according to the survey, participants, if they were throwing a party, were more likely to serve food with alcoholic beverages than they were to cut off drinking at a certain hour or to ask who is driving home as a way of controlling intoxicated driving. Finally, 76% reported that they had seen or heard advertising about drinking and driving in the past few months. A comparison of this survey with one taken the previous year showed no significant demographic differences between participants in the two surveys relative to age, marital status, sex distribution, or the proportion reporting that they drive a car. However, there was a large increase in the proportion rating the problem of drunk driving extremely important; an increase in the number reporting that they had been in a place during the previous three months where alcoholic beverages were served; and a significant increase in the proportion disagreeing with the ideas that beer is less intoxicating than an average drink of liquor, that coffee can sober you up, and that an average glass of wine is less intoxicating than an average drink of liquor. Decreases occurred in the proportion of those who said they were extremely likely to suggest that a drunk friend stay over night rather than drive home, and those stating that they were extremely likely to call a taxi.

by S. D. Rosen; L. T. Mattson; F. Romslo
University of Minnesota; Hennepin County Alcohol Safety Action Project, 625 Second Ave., Minneapolis, Minn. 55402
Contract DOT-HS-048-1-064
Rept. No. HCASAP-TS-76; 1976; 51p
Availability: NTIS

HS-802 135

YOU--ALCOHOL AND DRIVING

Eight readings examine drinking behavior and physiology; the differing effects of alcohol on individuals in differing circumstances, problems and dangers arising in a drinking/driving mix; suggestions as to how to avoid the drinking driver and how to influence the drinker not to drive, and the effects, any alcoholic liquid leads eventually to intoxication. The blood alcohol concentration (BAC) measures the amount of alcohol in your system at any given time. It varies with weight and time taken to imbibe. At a concentration of about 0.50%, death would be near. Hangovers have no cure; the only cure is time for the liver to process the alcohol. Alcohol affects vision (acuity, night, side, depth, and distance) and judgment, two skills most necessary for safe driving. In about one-half of all highway deaths, alcohol is involved; and about one-half of those involved in such accidents are not the ones drinking. At 0.15% BAC, chances of an accident are 25 times greater than when sober. The only answer is to limit drinking and know one's limit. Charts are provided to determine individual BAC. Drivers are warned to: beware reasons for drinking, as they can contribute to the drinking problem; know that drinking never helps performance; and know that each person has differing limits; to know that arrests for driving while intoxicated (DWI), usually defined as a 0.10% BAC or more, have doubled during the past five years, and, as a result, there are more severe penalities for DWI; special classes exist for drinking drivers; medical treatment exists for problem drinking drivers; and special Federal, State, and local programs have been set up to deal with problems of drinkers and drinking drivers. Separate drinking and driving. When involved in drinking by others, don't "push" drinking; control the supply when possible; take care of others; and don't allow them to drive. Suggest alternatives to driving after drinking. Conclusive evidence relating drug use to driving accidents is still being gathered. However, evidence does exist which indicates that drug use tends to increase accident risk. At least one out of seven fatally injured drivers had some sort of drug in his system at the time of the accident. Different drugs cause different responses, but all affect driver skills. The best advice is to avoid excessive drug use; avoid illegal drugs; read labels carefully; check with the doctor about drug effects; avoid taking others' drugs; and be cautious.

National Public Services Res. Inst.
Contract DOT-HS-5-01195
1976; 59p
Student portion of a three-part package of instructional materials. Also included in this package is a "Teacher's Guide to Alcohol Countermeasures for High School Driver Education" (Stock No. 3413) and "If You Drive, What About Drinking?," a package of 16 four color transparencies (Stock No. 3384) or 35 mm slides (Stock No. 3381).
Availability: Your local AA Club

HS-802 136

SCREENING FOR DRIVER LIMITATION

A manual to aid driver license examiners in recognizing signs and symptoms of medical conditions that may limit safe driving ability is presented in six units of discussion and exercise questions. General information is provided about specific medical problems such as: cardiovascular conditions, hypertension, hypotension, coronary artery disease, angina pectoris, cardiac pacemakers, syncope, coronary-bypass surgery; neurological conditions; epilepsy, central nervous system disorders, demyelinating disorders, neuritis, sciatica, vertigo; visual problems, nystagmus, eye hemorrhages, improperly fitted con-

illnos; casts; hearing problems; Meniere's disease; obesity; emphysema; narcolepsy; and chain smoking. A glossary of medical terms used in the text is appended along with a listing of sources of further information.

by Robert N. Pierron
National Hwy. Traffic Safety Administration, Washington, D.C., 20590
1976; 48p 33refs
Availability: GPO

HS-802 162

AN ANALYSIS OF TOTAL PROJECT IMPACT. NO:ASAP 0NEW ORLEANS ALCOHOL SAFETY ACTION PROJECT0 ANALYTIC STUDY NO. 1

Linear regression analysis of accident frequencies indicated that, for the city as a whole, the objective of detection, conviction, and rehabilitation of drunken drivers in New Orleans was not realized. Analysis of rotating saturation patrols of restricted areas of the city, however, indicated that intensive patrolling and increased driving while intoxicated (DWI) arrests did indeed reduce accident frequencies for some subsets. ASAP police patrols tended to arrest more drivers than regular patrols and to arrest persons with lower blood alcohol concentrations (BAC) than regular patrols. They also had fewer drivers refuse to take the test. Arrest frequencies for regular patrols did not change significantly during saturation patrolling. ASAP has never been demonstrated to have any effect on fatal accidents, a major project goal. Inspection of these data indicates that about 50% of those killed in New Orleans are pedestrians, and in the majority of these accidents the pedestrian is at fault. Given these restrictions, it is difficult to see how ASAP could have been expected to affect more than about two fatal accidents a month even if the project worked perfectly. In determining demographic characteristics of individuals entering the ASAP system, it was found that for females the only difference across 1974 and 1975 data was that the mean BAC level for white females was lower than the mean for black females. Regarding racial characteristics, it was found that though these are easily quantifiable, they are confounded with a host of other variables such as socioeconomic level and differences in subcultural and cultural backgrounds. While differences can be seen in the mean BAC between races, there is no way of knowing whether the differences seen in Alcohol Safety Enforcement Section (ASES) unit operation between 1974 and 1975 are differences in unit operation or differences in subject population caused by passage of time. The Public Information and Education (PI&E) effort entailed a roadside survey and two telephone surveys. BAC's obtained from the roadside survey were to be compared with those of the previous year. However, the results are not comparable, as breath testers were used in the second year and not the first. The telephone surveys provided no usa-

Analytical Studies. Number One. Project Impact. Prepared for New Orleans ASAP and National Highway Traffic Safety Administration as a subcontract to DOT-HS-059-1-076.
Availability: Reference copy only

HS-802 163

AN ANALYSIS OF ASAP PATROL ACTIVITIES NO:ASAP 0NEW ORLEANS ALCOHOL SAFETY ACTION PROJECT0 ANALYTIC STUDY NO. 3

The Alcohol Safety Enforcement Section (ASES) concentrated its activities from 9 pm to 5 am, Tuesday through Saturday. The enforcement period encompassed six weeks prior to selective enforcement, the six weeks of selective enforcement, and the six weeks after selective enforcement. During the continuation period, a sequence of saturation patrolling in selected areas of the city was introduced, a change from the previous enforcement strategy of citywide patrolling. During saturation patrolling, arrests in the area increased, and all categories of accidents decreased, the most significant category being multivehicle property damage accidents. Total property damage accidents were highest prior to selective enforcement, and at no time did they return to the original high number following the enforcement period. There was no evidence in these data that saturation patrols caused a substantial decrease in the number of drinking drivers within the area. While the ASES patrols were in the selective enforcement areas, there was no significant change in regular patrol arrests. Since the decrease in accidents in the selective enforcement patrol areas was accompanied by an increase in the amount of time the police were on the street, as well as an increase in the number of arrests, the change in accident rates during the selective enforcement period cannot be ascribed at this time to either of these variables. Comparisons between ASES arrests and regular patrol arrests demonstrated that ASES patrols arrested drivers with a lower blood alcohol content (BAC) than regular patrols and have fewer drivers refuse to take the BAC test than do regular patrols. It was also shown that ASAP officers were in no way "drying up" the areas of the arrests. Because of an absence of definitive data concerning the driving habits of groups based on race and sex, the differences seen in the demographic composition are uninterpretable. Finally, roadside survey data were not considered appropriate for projection to arrest data, as the survey data were collected only during a restricted period on Friday and Saturday nights.

by Clifford J. Herbert; John Duffy
Louisiana Computing Corp., 3444 Olympic Drive, Metairie, La. 70003
1976; 50p
Cover title: New Orleans Alcohol Safety Action Project. Analytical Studies. Number Three. Enforcement. Prepared for New Orleans ASAP and National Highway Traffic Safety Administration as a subcontract to DOT-HS-059-1-076.
Availability: Reference copy only

model to predict traffic accidents derives from equations redicting molecular behavior and is of the random effect pe. The data used were weekly: the total numbers of accidents, nighttime accidents, daytime accidents, and weekend cidents. A lineal regression interrupted time series analysis as used as others were found inadequate or unreliable. Three terrupts were incorporated: the start of ASAP; the start of e Super Dome construction which brought more people and nstruction to the area; and the change of the Louisiana eed limit from 70 to 55 mph. Accidents were categorized as ngle or multivehicular, involving property damage or perinal injury. Two statistics developed by the model, the robability that an accident will occur and the residuals from cident frequency prediction, can be used to evaluate traffic fety programs. Analysis of data developed from the model dicates that the initiation of the ASAP in New Orleans led to significant lowering of some categories of daytime personal jury and property damage, especially that found in single-hicle accidents.

y Clifford J. Hebert; John Duffy
ouisiana Computing Corp., 3444 Olympic Drive, Metairie,
a. 70003
ontract DOT-HS-059-1-076
976; 53p
over title: New Orleans Alcohol Safety Action Project.
nalytical Studies. Special Study. Mathematical Model of
raffic Accidents. Prepared for New Orleans ASAP and
lational Highway Traffic Safety Administration as a
ubcontract to DOT-HS-059-1-076.
vailability: Reference copy only

IS-802 165

N ANALYSIS OF ASAP IMPACT ON THE JUDICIAL YSTEM. SD:ASAP 0SOUTH DAKOTA ALCOHOL AFETY ACTION PROJECT0 ANALYTIC STUDY NO. . INTERIM REPORT. 1976

D:ASAP's enhancements to the traffic safety system were oncentrated in traffic enforcement on the one side of the judiciary, and drinker diagnosis and driver/alcohol treatment rograms on the other side. As such, the ASAP did not proide prosecution or court scheduling assistance that might alviate any potential burden of a large increase in caseload. he rate of driving while intoxicated (DWI) arrests tripled durg the ASAP period, totaling over 16,000 arrests for the four ears. Of these arrests almost 14,000 had known final court isposition of which 84.3% were convicted. The ASAP court-/orker staff provided presentence investigations and drinker iagnoses for 76% of the convictions, 60% of which ultimately ompleted the court referred alcohol treatment program. Judiial performance comparisons between the project period and he baseline period (1968-1971) showed that the conviction rate ropped 7.7% during the operational period. Additionally, the acklog of DWI court cases increased such that the median lapsed time between arrest and final disposition increased rom only five days during the baseline period to over seven-een days during the operational period. A comparison of lood alcohol concentration (BAC) distributions showed that he operational period distribution had shifted significantly

by Philip B. Krause
University of South Dakota, Human Factors Lab., Vermillion, S. Dak. 57069
Contract DOT-HS-045-1-061
1976; 50p
Rept. for 1 Jan 1972-31 Dec 1975. Prepared for South Dakota ASAP as a subcontract to DOT-HS-045-1-061.
Availability: Reference copy only

HS-802 166

ANALYSIS OF OVERALL PROJECT IMPACT 1975. SAN ANTONIO ALCOHOL SAFETY ACTION PROJECT. ANALYTIC STUDY NO. 1-2

All countermeasures of the San Antonio ASAP (Alcohol Safety Action Project) operated essentially as planned. The enforcement countermeasure saw 17 new police cars, 5 new breathalysers and 5 simulators; ASAP-trained patrols were in effect throughout the city, made up of 165 policemen. The adjudication countermeasure saw to the continued ASAP diagnosis and referral programs and the continuation of rehabilitation efforts in educational schools and a variety of other treatment programs. The public information and education countermeasure continued with 75% of the drinking drivers reached, according to voluntary roadside survey (VRS) data collected. Along with the publicity surrounding a Congressional Subcommittee Hearing in San Antonio on its Alcohol Safety Action Project, national and local media campaigns were continued, and the pilot curriculum of ASAP materials presented in four high schools is being considered for implementation throughout the Texas school system. However, social and economic environmental changes occurred: population increased by 26.8% , rainfall rates were considerably above normal; the fuel shortage produced a 12.8% decrease in serious accidents, but the accident rate continued to grow at the end of the shortage, and the age of legal purchase of alcoholic beverages went from 21 to 18. Although ASAP made substantial progress in arresting drunk drivers, helping modify judicial systems to reflect the ASAP systems approach, providing rehabilitation modalities, and in educating the general public to the seriousness of the problem of drunk drivers, there were still increases in alcohol-related fatal and injury accidents over the ASAP period. Two possible reasons exist for this lack of success: three years' time simply was not enough to substantially alter drinking and driving patterns which had prevailed for many years; and the magnitude of the problem was more significant than was imagined.

by Thomas E. Hawkins; Charles B. Dreyer; Evelyn J. Cooper
Southwest Res. Inst., P.O. Drawer 28510, 8500 Culebra Rd., San Antonio, Tex. 78284
Contract DOT-HS-049-1-065
1976; 19p
Availability: Reference copy only

HS-802 167

PROJECT DIRECTOR'S REPORT. SAN ANTONIO ALCOHOL SAFETY ACTION PROJECT. ANNUAL REPORT 1975. SECTION 1

Project management and evaluations countermeasures showed the need for more personnel, and professional and clerical people were hired. Functions of administration, countermeasure coordination, and operation are proceeding efficiently. In the enforcement countermeasure, additional officers were trained, vehicles purchased and equipped, and new breathalyzers were put into operation. Driving while intoxicated (DWI) arrests have increased 450% over historical levels. Breathalyzers' use takes an excess of 60 minutes per DWI and methods to decrease this time are being studied. In the judicial countermeasure, five new county court-at-law judges were elected. The courts heavily utilized the Problem Drinker Evaluation Center (PDEC) and the rehabilitation modalities offered by ASAP. PDEC diagnoses the extent of the drinking problem of the guilty DWI and recommends rehabilitation alternatives. In the rehabilitation countermeasure, four activities are being used: an alcohol information and driver education program; an alcohol treatment program; power motivation training; and a life activities inventory. Of these four, the ten-hour AIDE school, operated once a week for four weeks with 30 students per class, is completely self-supporting at a fee of $16 a week. It seeks to rehabilitate the social drinker. The public information and education countermeasure supports voluntary roadside surveys (VRS); reinforces the National Media Campaign "know your limit," designed a "fear of arrest" campaign, and has put into operation a Driver Education Pilot Program in one school district with the goal of wider use as its effectiveness is tested. A fiscal review shows some significant underruns and overruns, with steps being taken to adjust the budget accordingly. Finally, the ASAP program has inspired visits from other county probation officers interested in utilizing education and treatment programs with their DWI's.

by Kenneth F. Langland
San Antonio Alcohol Safety Action Project, San Antonio, Tex.
Contract DOT-HS-049-1-065
1976; 22p
Availability: Reference copy only

HS-802 168

SIOUX CITY--WOODBURY COUNTY ALCOHOL SAFETY ACTION PROJECT. ANNUAL REPORT. JANUARY 1-DECEMBER 31, 1975

The last six months of the federally operated ASAP and the first six months of the same program operated locally are compared in the areas of enforcement, courts, and judicial, rehabilitation, public information and education, and management and evaluation. Enforcement under federal funding provided for ten specially trained officers, which number was reduced to four under local funding. Patrolling strength was also reduced. Consequently, arrests dropped during the last six months by approximately 30%. Because of uncertainty regarding funding during the local phase, the courts experienced great anxiety and a drop in morale, and sought to reduce the caseload significantly. As a result the conviction rate for operating motor vehicles under the influence (OMVUI) arrests was lower than any of the rates for the previous five years. The rehabilitation program was continued in full under local funding and it showed continuing success by having a lower

received any rehabilitation. Despite the low priority fund
for public information and education under local control,
program continued to receive good support from the lo
media and in the local schools. Based on household and ro
side survey data, there was a statistically significant increa
in the awareness of the legal limit of intoxication and
knowledge of the meaning of blood alcohol content (BA
Management and evaluation functions were transferred
local auspices gradually and it is felt that local management
more effective than management by outside sources. Final
the impact of the ASAP program on accidents has resulted
a lowering of alcohol-related fatal accidents: during the fi
six months of 1975 there were a total of 14 fatal accidents
which six were alcohol related; during the last six months
1975 there were only six fatal accidents of which only one w
alcohol related. However, it was shown that project patrolli
activity has a lag effect or impact on fatal accidents and the
fore OMVI arrests and patrolling do not impact on fatal a
cidents until a later date. Tables and figures are provide
along with appendices.

Iowa Alcohol Safety Action Project
Contract DOT-HS-163-2-256
1976; 184p
Availability: Reference copy only

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Institute of Electrical and Electronic Engineers, Automotive Electronics Com.
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National Bureau of Standards, Washington, D.C. 20234
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National Com. on Uniform Traffic Laws and Ordinances, 1776 Massachusetts Ave. N.W., Washington, D.C. 20036
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TRANSPORTATION ENERGY CONSERVATION DATA BOOK. 1ST ED.
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Olin Corp., Engineering and Devel., Marion, Ill. 62959
DEVELOPMENT OF IMPROVED INFLATION TECHNIQUES. VOL. 1. FINAL REPORT
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Onan Corp., Onan Div.
AN IONIZATION PROBE STUDY OF SMALL ENGINE COMBUSTION CHAMBERS
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Organisme National de Securite Routiere, Laboratoire des Chocs et de Biomecanique, 109 Ave. S. Allende, 69500 Bron, France
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